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PB-257 135

FEASIBILITY STUDY, DEER PARK DAYLIGHTING PROJECT

ANKENHEIL AND ASSOCIATES GEO SYSTEMS, INC.,

PREPARED FOR
INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY

JUNE 1976

253010

PB 257 135

EPA-600/2-76-119
June 1976

Environmental Protection Technology Series

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PB257135

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/2-76-110	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE FEASIBILITY STUDY DEER PARK DAYLIGHTING PROJECT	5. REPORT DATE June 1976 (Issuing Date) 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) A. R. Richardson M. T. Dougherty	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Ackenheil & Associates, Incorporated 1000 Banksville Road Pittsburgh, Pennsylvania 15216	10. PROGRAM ELEMENT NO. EHE 263 11. CONTRACT/GRANT NO. S-801353
12. SPONSORING AGENCY NAME AND ADDRESS Industrial Environmental Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268	13. TYPE OF REPORT AND PERIOD COVERED Feasibility 9/3/72 - 3/3/73 14. SPONSORING AGENCY CODE EPA-ORD
15. SUPPLEMENTARY NOTES	

16. ABSTRACT

The study was performed to determine the technical and economic feasibility of daylighting abandoned deep coal mines as a method to abate acid mine drainage by employing common surface mining and backfilling techniques. Data on the present water quality of Lost Run, Garrett County, Maryland was obtained and used for the evaluation of using daylighting as a method to improve water quality. Other criteria were thickness, quality and amount of coal in-place. A mining and reclamation plan was developed for the daylighting. This plan was devised based on the acidity of overburden material, the estimated coal in-place, and erosion control methods to reduce siltation.

The feasibility study results indicate this demonstration project would be technically and economically feasible and that reclamation would effectively produce usable land and improve water quality. The estimated cost of the demonstration project is about $500,000 for a 70 acre (28 hectare) site. The major obstacle in implementing the project is aquiring rights, easements and methods of awarding contracts.

PRICES SUBJECT TO CHANGE

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
*Coal Mines, *Strip Mining, Underground Mining, *Overburden, Chemical Properties, *Water Pollution, Reclamation, Cost Analysis, Acidity, ph Control, Drainage, Erosion Control	Contour Mining, Strip Mine Wastes, Underground Mine Waste, Acid Mine Drainage, Environmental Protection, Mine Waters	8G 8I 13B

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified 20. SECURITY CLASS *(This page)* Unclassified	21. NO. OF PAGES 88 22. PRICE $5.00 - 2.25

*USGPO: 1976 — 657-695/5451 Region 5-11

EPA-600/2-76-110
June 1976

FEASIBILITY STUDY

DEER PARK DAYLIGHTING PROJECT

by

A. R. Richardson and M. T. Dougherty

Ackenheil & Asscciates, Incorporated
Pittsburgh. Pennsylvania 15216

Grant Number S-801353

Project Officer

Elmore C. Grim
Resource Extraction and Handling Division
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
CINCINNATI, OHIO 45268

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FOREWORD

When energy and material resources are extracted, processed, and used, these operations usually pollute our environment. The resultant air, land, solid waste and other pollutants may adversely impact our aesthetic and physical well-being. Protection of our environment requires that we recognize and understand the complex environmental impacts of these operations and that corrective approaches be applied.

The Industrial Environmental Research Laboratory - Cincinnati assesses the environmental, social and economic impacts of industrial and energy-related activities and identifies, evaluates, develops and demonstrates alternatives for the protection of the environment.

In this report the technical and economic feasibility of "daylighting", the removing and replacing of the overburden above a coal seam, was evaluated as a means of abating acid mine drainage (AMD) pollution. AMD, which is formed by the oxidation of pyritic material, is one of the major sources of stream pollution in the eastern United States. The conclusion of the report is that "daylighting" can be used to eliminate AMD from certain abandoned mine workings, and that "daylighting" also enhances the use potential of the land, and minimizes the risk of future erosion and stream siltation.

Results of this work will be especially interesting to State and Federal agencies concerned with reclamation of abandoned mines and to mining firms searching for additional coal reserves.

David G. Stephan, Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

The study was performed to determine the technical and economic feasibility of daylighting abandoned deep coal mines as a method to abate acid mine drainage by employing common surface mining and backfilling techniques. Data on the present water quality of Lost Run, Garrett County, Maryland was obtained and used for the evaluation of using daylighting as a method to improve water quality. Other criteria were thickness, quality and amount of coal in-place. A mining and reclamation plan was developed for the daylighting. This plan was devised based on the acidity of overburden material, the estimated coal in-place, and erosion control methods to reduce siltation.

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This report was submitted in fulfillment of Environmental Protection Agency Project S-801353, by Ackenheil & Associates Baltimore, Md., Inc., under the partial sponsorship of the Environmental Protection Agency and the State of Maryland, Department of Natural Resources. Work was completed of March 3, 1973.

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ACKNOWLEDGMENTS

Mr. John Matis, Department of Natural Resources, State of Maryland, served as Project Director during this feasibility study. Mr. Matis' technical and administrative assistance during this project is gratefully acknowledged.

The study was performed in collaboration with Potomac Engineering and Surveying, Oakland, Maryland. Potomac Engineering and Surveying provided field crews for surveying, water sample collection and provided technical advise for the project. Mr. Henry Moomau served as Project Engineer for Potomac Engineering and Surveying.

Water testing was performed by the Maryland Water Resources Administration Laboratory in Cumberland, Maryland.

SECTION I

CONCLUSIONS

The following conclusions are the opinion of the consultant based on the data obtained and the study leading to the project implementation plans presented in Section VI

TECHNICAL FEASIBILITY

Project Is Technically Feasible: It is the consultant's opinion that, if conducted in accordance with the plans of Section VI, daylighting and reclamation can be accomplished within current Maryland Mining Law by using the equipment and methods of operating commonly employed in strip mining in the area.

Reclamation Will Be Effective: It is the consultant's opinion that grading, treating and planting according to the plan presented in Section VI will produce about 70 acres (28 hectares) of land with vegetative cover, suitable for a variety of uses.

Minimum Risk Of Erosion: It is the opinion of the consultant that, if the erosion control measures specified in Section VI are followed, the risk of future erosion will be minimized.

Minimum Future AMD: Daylighting according to the plan set forth in Section VI should result in reduction to a minimum or elimination of AMD from the abandoned deep mine workings.

IMPACT ON WATER QUALITY

Based on the data previously presented, it is estimated that the daylighting project will result in a significant reduction in the pollution load discharged by Lostland Run into the North Branch of the Potomac River.

ECONOMIC FEASIBILITY

Budget For Project Completion: It is estimated that the project can be accomplished at less than the costs budgeted in the grant application and within the proposed budget presented in Section VII and summarized as follows:

Construction Costs Estimated At:	$281,260.00
Engineering Costs Estimated At:	$191,225.00
Water Testing And Soil Testing Costs Estimated At:	$ 10,250.00
Total Estimated Budget To Complete:	$482,735.00

Estimated Maryland salaries and expenses for Phase II and III are not included in the above. It must be again emphasized that the estimated credit from the sale of the coal, which has been deducted to estimate the net construction costs above, is subject to significant variation if the price of coal varies or if the amount of coal in place is other than the percent estimated.

PROPERTY PURCHASE AND CONTRACTUAL ARRANGEMENTS

Major Obstacle: It is the opinion of the consultant that the major obstacles to implementation of the project will be:

Acquiring title to the surface and mined rights or securing of easements which satisfy the State of Maryland and the Environmental Protection Agency's legal requirements.

Arriving at a method for awarding the contract and a type of contract acceptable to the State of Maryland and the Environmental Protection Agency.

SECTION II

RECOMMENDATION

Based on the conclusions of the preceeding section, it is recommended that the demonstration phase of the project be ititiated. It is technically feasible and can be performed within the budget of the EPA Grant. It is anticipated that the project will have a significant impact on the water quality of Lostland Run.

SECTION III

INTRODUCTION

GENERAL

Demonstration Project Feasibility Report: This report discusses the feasibility of performing a "Daylighting" demonstration project in Garrett County, Maryland.

Work on the feasibility portion of the project has been in progress since September 5, 1972. Initiation of work followed a grant offer from the Environmental Protection Agency (EPA) to the State of Maryland on June 15, 1972 and subsequent acceptance of that offer by the State of Maryland. The grant for the Demonstration Project is covered under Section 107 of the Federal Water Pollution Control Act and is assigned Project No. S-801353.

The total project, originally scheduled over a four-year period, is broken into three distinct work phases. Phase I involves a feasibility study, Phase II includes design and construction operations, and Phase III permits post-construction evaluation. This report transmits results of Phase I which has been completed.

Acid Mine Drainage Pollution Abatement: Pollution of streams by oxidation reaction products of impurities in the coal and associated coal measure rocks exposed during mining is one of the major deteriorating effects on the environment. Pollution from acid mine drainage can originate from either surface or deep mining operations.

Current mining and water quality laws in most, if not all, of the states in the bituminous coal region require discharge permits and plans of mining operations directed toward minimizing the effects of siltation and acid mine drainage pollution during active mining. Reclamation of strip-mined land can be accomplished in such a manner that future discharge of acid mine drainage will be minimal. Most states require elimination or treatment of polluted discharges from deep mine workings to be provided on a long-term basis by a mining company wishing to stop operations.

Particularly troublesome sources of AMD in streams of coal-producing regions are abandoned deep mines. Determining ownership, fixing responsibility and formulating legislation requiring abatement are difficult or impossible. Usually such pollution sources are truly "orphans". In addition, at the source methods of abatement of AMD from abandoned deep mines are expensive and of limited effectiveness. Treatment methods are also costly and require a continuous expenditure of money.

Daylighting As A Method Of Acid Mine Drainage Pollution Abatement: Various techniques have been developed and demonstrated for the abatement of acid mine drainage from abandoned deep mine workings. These techniques have included sealing mines, diversion of water on the surface to prevent its entering mine workings, grouting of overlying water-bearing strata, grouting the mine workings, collapsing the mine workings, flooding the mine workings, or otherwise attempting to exclude air from the workings and providing treatment of the discharge.

One technique which has often been suggested is "daylighting" and requires only knowledge of ordinary current common technology. Daylighting would be accomplished by removal of the overburden over abandoned mine workings, removal of the coal and other acid-producing or potentially acid-producing materials and replacement of the overburden to reclaim the site. Potentially acid-producing material which was not salable would be buried at such depths and locations as would minimize future possibilities for acid production.

Requirements For Daylighting: The technique of daylighting, as a method of acid mine drainage abatement, is potentially applicable to many abandoned mine workings in the bituminous coal fields of eastern United States. In regions of severely dissected topography where the attitude of the underlying rocks is horizontal or gently dipping, it is common to find isolated hills or knolls with a coal seam outcropping circumferentially around the hill. Very often these seams of coal have been deep mined and contain abandoned workings. Typically, the outcrop has been or is being removed by the contour strip mining method. If the abandoned mine workings in a coal seam outcropping circumferentially are sources of acid mine drainage pollution, daylighting would be an effective technique for abating this pollution.

The choice between daylighting and other applicable techniques would be based on the relative costs of the various techniques. The feasibility of daylighting would depend on the thickness and character of the overburden which would have to be removed. The cost of daylighting would also depend on the thickness and character of the overburden material, but in addition, would be closely controlled by the quantity and quality of salable coal remining in the abandoned mine workings.

In some instances the cost could be reduced by incorporating daylighting with an active or planned strip mining operation.

In addition to elimination of a source of AMD pollution, reclamation of abandoned strip mine workings and enhancement of the land use potential of the property above the abandoned mine workings would frequently be added benefits from a daylighting operation.

PURPOSE AND SCOPE

Purpose: The purpose of the Deer Park Daylighting Project is as follows:

To demonstrate the technical feasibility of daylighting at a site chosen as typical of sites where such a method of abating acid mine drainage would be applicable. The techniques to be employed are those commonly used in surface mining in the region and no special excavation, backfilling or grading will be employed. The entire operation will be in conformity with the current State of Maryland mining law.

To establish the costs of a typical daylighting operation.

To demonstrate the effectiveness of daylighting as an acid mine abatement technique by water quality monitoring before, during and following the daylighting.

Scope Of Work To Date: A pre-feasibility study conducted jointly by the State of Maryland and the Consultant involved:

A study of mining and geology in Western Maryland.

A review of available data relevant to acid mine drainage pollution in Western Maryland.

Location on the USGS 7-1/2 minute topographic Quadrangle Maps of sites in Western Maryland which would seem suitable for a demonstration project.

Conferences with the Maryland Bureau of Mines and the Maryland Land Reclamation Committee and selection of the sites estimated to be most suitable for a demonstration project.

Visits to the sites and discussions with property and mineral right owners and mine operators.

Selection of a site for a demonstration project.

Based on the information obtained, an application was submitted to the Environmental Protection Agency for a Demonstration Project Grant.

Following the award to the State of Maryland of a grant for a Demonstration Project, Phase I of the project was undertaken. The purpose of Phase I was to determine the feasibility of performing the project within the budget indicated in the grant, to obtain data on which to base detailed plans and specifications, and to establish a program of water quality monitoring. The scope of Phase I is as follows:

Set up a program for water quality monitoring.

Gather water quality data on which to base an opinion on the effect of the project on the water quality of Lostland Run.

Perform a topographic survey.

Study the field geology.

Prepare a Preliminary Site Plan showing proposed final topography.

Recommend a plan for mining and reclamation.

Estimate quantities and costs.

Prepare a property ownership map.

Prepare a report presenting the preceding information and an opinion on the feasibility of the project.

JURISDICTIONAL FRAMEWORK

Cognizant Authority: This project is being undertaken by the Water Resources Administration, an agency of the Department of Natural Resources of the State of Maryland.

Legislation: The legislation authorizing the expenditure of funds for the project is the Abandoned Mine Drainage Control Act of 1970, Article 66C, Section 674, A through H, of the Maryland Code as found in the 1970 Replacement Volume as amended.

Contracting Agency: The contracting agency for this project is the Water Resources Administration, an agency of the Department of Natural Resources of the State of Maryland.

Administrative Agency: The work under contracts on this project will be administered by the Water Resources Administration of the State of Maryland.

Water Quality Standards: Water quality standards which regulate discharge into any of Maryland's waters have been established by the Department of Water Resources (now the Water Resources Administration). Water quality in the streams of Maryland is regulated by the Water Resources Law of Maryland, Article 96-a of the Annotated Code of Maryland, 1967 and 1972 Cumulative Supplement. Under this law, water quality must conform to Water Resources Regulation 4.8, "General and Specific Water Quality Criteria and Water Quality Standards for All Maryland Waters." A permit for discharge into any Maryland water is required and discharge must conform to State of Maryland Water Resources Regulation 4.7, "Requirements for Discharge Permit."

Higher Public Use of Waters: No legislation relative to the higher public use of water is known to have bearing on the daylighting project. Since no dams or impoundments other than the siltation basins are involved, no permits would be required. No diminishing of the quantity of water in Lostland Run will occur and thence no riparian water rights are involved.

Land Use Standards: No particular land use standards are known to exist for the general area in which the site is situated. It is proposed to return the site to the same land use category which existed prior to mining, i.e., agriculture, forest and wildlife.

Mining Laws and Reclamation Committee: The Daylighting Project will fall under the "Strip Mining Laws of the State of Maryland, 1971," a copy of which is included in the Appendix to this report. In order to proceed with the daylighting, a permit must be obtained and renewed annually as indicated in the mining law.

The Mining Law creates a "Land Reclamation Committee" whose duties include approval of all procedures for reclamation, conservation and revegetation of areas affected by open-pit mining within the State of Maryland. The plans for the daylighting project must meet the approval of this Reclamation Committee.

Site Acquisition: According to the Director of the State of Maryland, Water Resources Administration, lands involved in projects found under this authority must be purchased in Fee Simple by the State of Maryland or easements obtained which satisfy the requirements established in the Abandoned Mine Drainage Control Act of 1970. Consequently, a Negotiator with the Department of Natural Resources is now negotiating for acquisition of surface and mineral rights to the project area. Acquisition by the State of Maryland of all property included in the project by Fee Simple or by suitable easements will effectively control any future mining of the site.

Funding Authority: The Funding Authority for this project is the Water Resources Administration of the State of Maryland, as indicated previously in the description of the affecting legislation.

Water and Mineral Rights: No water rights will be affected by the Project. Discharge from the project site enters Lostland Run within the boundaries of the Potomac State and Forest and Lostland Run remains within the State Land to its discharge into the North Branch of the Potomac River.

State Ownership of Land: The Ownership of the Project Land by the State of Maryland or the possession by the State of Maryland of satisfactory construction easements will give control of any future pollution from the project site to the State of Maryland.

Existing Mining Laws and Water Quality Standards: The existing mining laws and water quality standards of the State of Maryland (See Appendix) regulate discharge from future mining and this will effectively control possible future pollution of Lostland Run from any new mining operation.

Mining on State Owned Lands: Any strip mining now in progress on state-owned land must be completed within six months. After that time, no mining will be permitted on state-owned land. Thus, following the completion of the current Buffalo Coal Company stripping operation along South Prong, Lostland Run no future stripping along South Prong, Lostland Run is anticipated.

SECTION IV

DESCRIPTION OF PROJECT AREA

LOCATION

The Demonstration Project Site is located in Western Maryland about four miles southeast of Deer Park. As shown on Figures 1 and 2, the project site is in the southeastern part of Garrett County. Lands of the Potomac State Forest surround the majority of the site at distances ranging from about one-half to one mile (one to two kilometers). Western Maryland is a beautiful, mountainous region, situated in the Appalachian Mountains and well-known internationally for its scenery.

Garrett County, Maryland is an important recreational region reasonably convenient to Baltimore, Maryland, Washington, D. C. and environs and the Pittsburgh metropolitan area. The importance of this region as a recreational area will increase greatly with the completion of the "National Freeway" which will bring the county within a three-hour drive of Metropolitan District of Columbia.

The Deep Creek Lake recreational area is well-known and popular. It lies about 7 miles (11 kilometers) north of the project site.

Oakland, the county seat of Garrett County, is about 7 miles (11 kilometers) east of the site. The area surrounding Oakland is increasing in light industrial importance especially since a project funded by the Appalachian Regional Commission has created an industrial park. Bosh and Lomb, among other light industries, have constructed a plant in this industrial park.

Deer Park is an abandoned summer resort famous in the late 19th century for its mountain scenery and water. Convenient to Washington, D. C. by railroad, Deer Park Hotel boasted one of the first indoor swimming pools in the United States. Many well-known government officials and D. C. celebrities vacationed regularly in Deer Park. President Grover Cleveland honeymooned at Deer Park and the cottage in which he and his bride celebrated their marriage is still standing. Deer Park water is still bottled and marketed commercially.

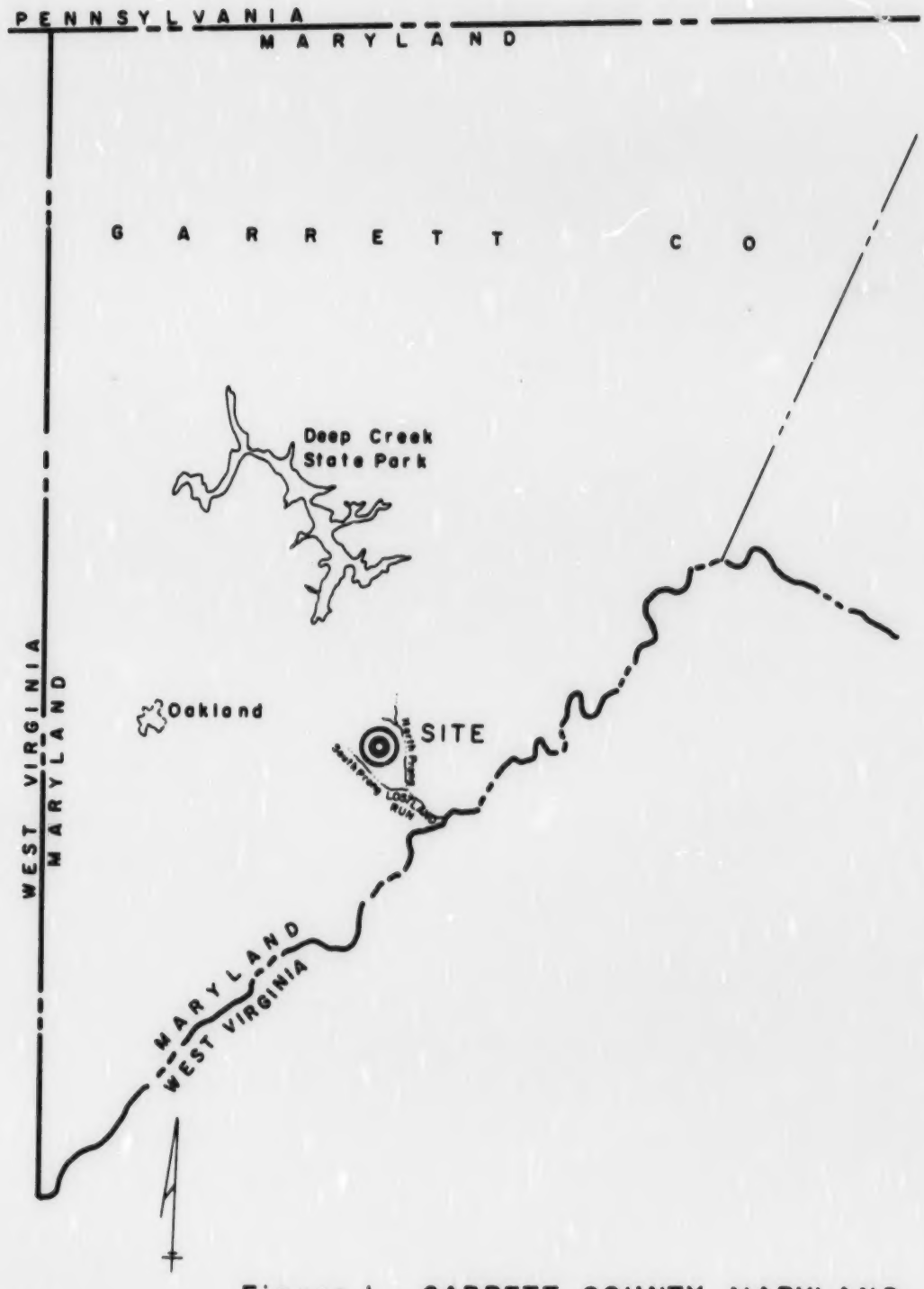

Figure I - GARRETT COUNTY MARYLAND

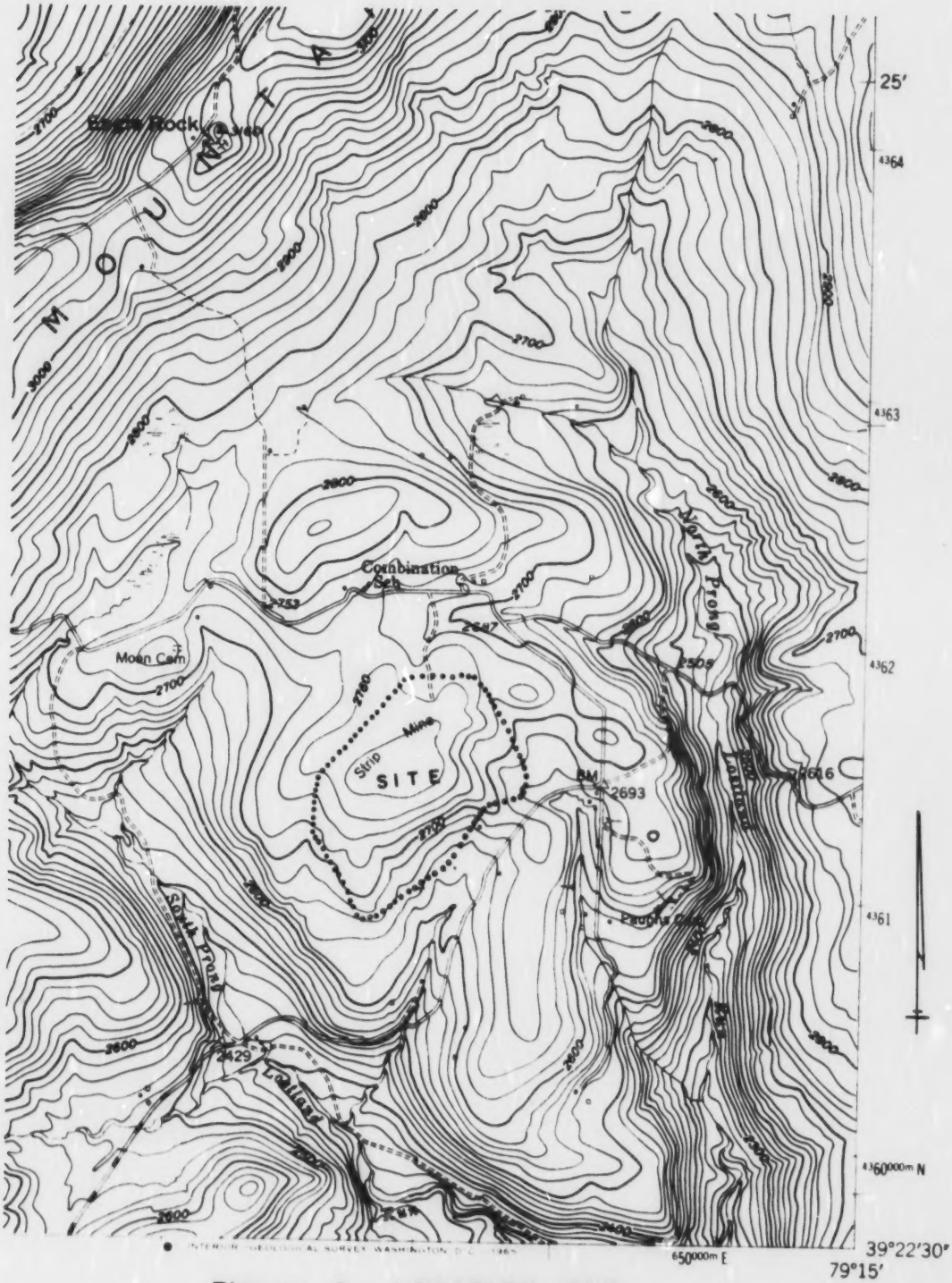

Figure 2 - LOCATION MAP SCALE 1" = 2000'

PROJECT AREA

The Demonstration Project Site comprises a total area of about 70 acres (28 hectares). Deep mine discharge from the site was recorded in the "Western Maryland Mine Drainage Survey," 1962-1965. At the time of project start-up, about 30 acres (12 hectares) were affected by: (1) a small, in-progress stripping operation (Uphole); (2) a stripping operation in which coal removal is complete but the reclamation of which is to be incorporated into this project; (3) abandoned strip pits and old spoil banks; (4) small orphan gob piles from deep mining operations. The remainder of the site consists of about 25 acres (10 hectares) within the strip mine highwalls consisting of a central knoll which is underlain with deep mine workings (See Figure 3 for a photograph of the area).

TOPOGRAPHY

The topography of the area is rugged. Located in the ridge and valley topographic province, the Upper Potomac Basin locally has elevations ranging from about 1000 feet (300 meters) about M.S.L. in the vicinity of the North Branch of the Potomac River to about 3000 feet (900 meters) on Backbone Mountain, just north of the site. The valley walls of the tributaries leading to the North Branch are steep, with slopes of 25% not uncommon.

GEOLOGY

The project area is situated on the flank of Backbone Mountain in what is known geologically as the Upper Potomac Basin. Within this basin, the rock strata are of Pennsylvania Age and include the Conemaugh, Allegheny, and Pottsville Formations.

As indicated on Figure 4, the prominent feature which influences the geology of the area is the Deer Park Anticline. The axis of this structure is located approximately 4-1/2 miles (7.2 kilometers) northwest of the project area and trends northeast-southwest. The rock strata dip southeasterly from the axis of the anticline, steeply in the area northwest of the project area but more gently in the vicinity of the North Branch of the Potomac River.

The individual rock strata which are present in the Upper Potomac Basin are shown in typical cross-section in Figure 5. Bedrock members of the Conemaugh formation are predominantly gray to brown claystones, shales, siltstones, sandstones, and coals. In the lower portion of the Conemaugh Formation, these strata are commonly interspersed with beds of red claystone, calcareous claystone and fossiliferous marine shales. The Allegheny Formation, for the most part, is composed of interbedded sandstones, siltstones, claystones, shales and coals. The Pottsville Formation, particularly the lower section, is characterized by an abundance of medium to coarse grained sandstones. The upper portion of the Pottsville is similar in stratigraphy to the Allegheny Formation.

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Figure 3 - PHOTOGRAPH OF SITE

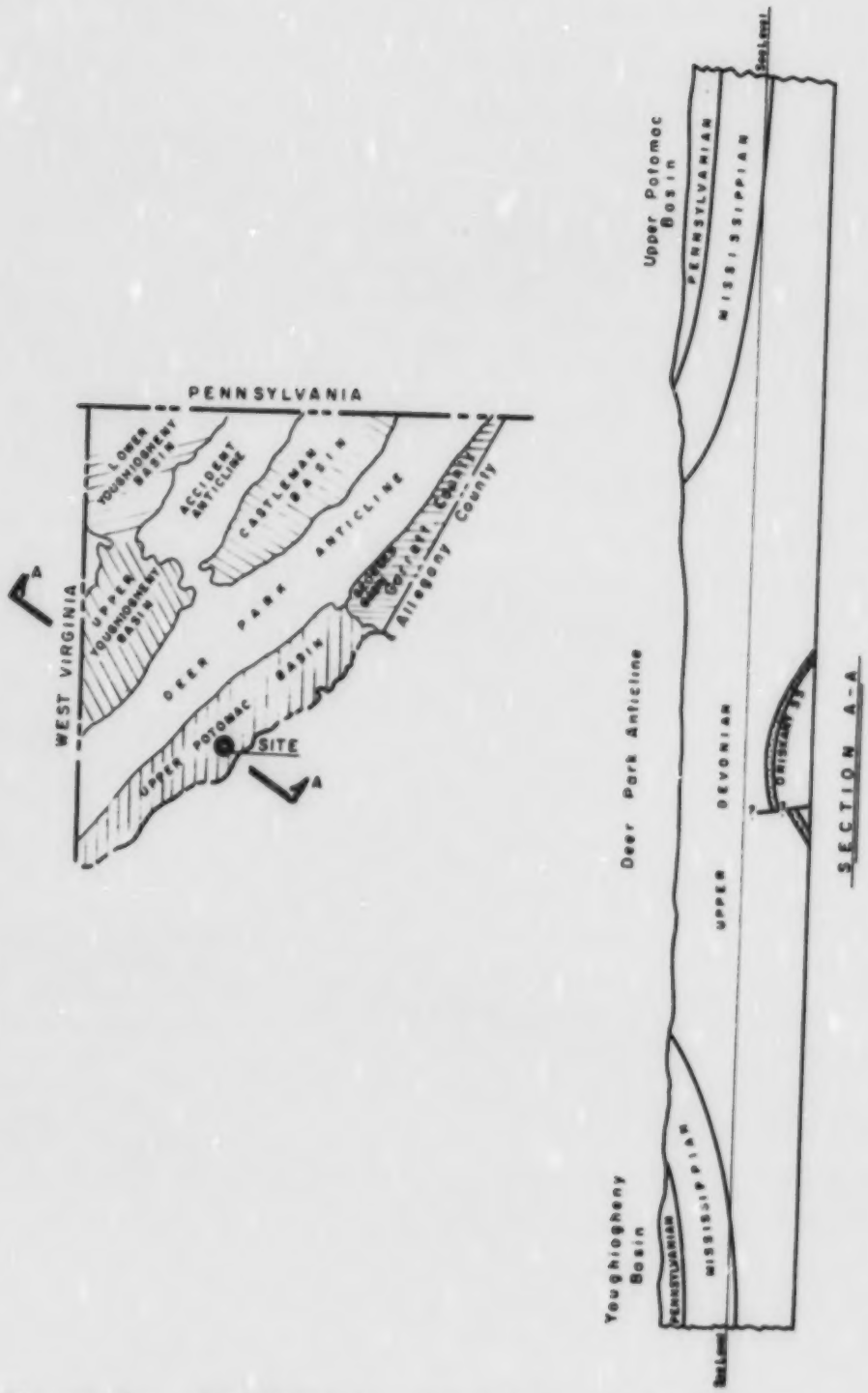

Figure 4- GARRETT COUNTY GEOLOGY

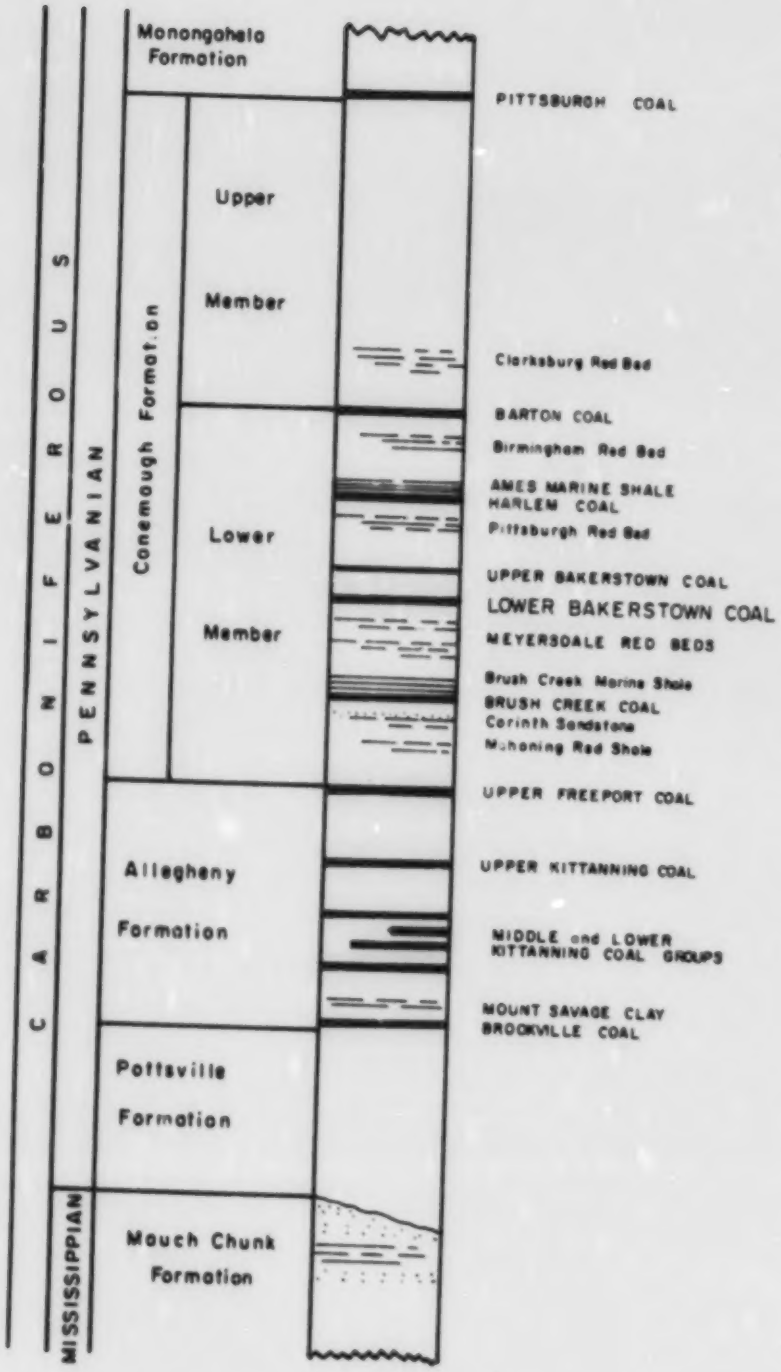

Figure 5 - GENERALIZED GEOLOGIC SECTION

The coal horizons which are important to the area include the Barton, Harlem, Upper Bakerstown, Lower Bakerstown, Brush Creek, Upper Freeport, Lower Freeport, Upper Kittanning and Middle and Lower Kittanning.

Locally, much confusion exists as to the naming of these coal seams. For example, the Lower Bakerstown Coal which is the seam of interest in this project is often referred to as the Upper Freeport; in the adjacent Georges Creek Basin, this seam is commonly known as the Lower Freeport. Locally, it is known as the Thomas Coal. Actually, the Lower Bakerstown Coal does not correlate with either the Upper or Lower Freeport Coal in adjacent Pennsylvania.

WATERSHED

On North Branch Potomac River: The project site is located in the drainage basin of the North Branch of the Potomac River, which forms the boundary between Maryland and West Virginia just south of the site. The North and South Branches of the Potomac River join southeast of Cumberland to form the Potomac River which flows through our Nation's Capitol.

Lostland Run: The site for this demonstration project is situated near the center of Lostland Run Watershed. This watershed drains an area of almost 6,300 acres (2,670 hectares) (approximately 9.8 square miles or 25.4 square kilometers).

As indicated on Figure 6, the Lostland Run Watershed is generally triangular shaped with all major streams flowing in a southerly or southeasterly direction. At the apex of the triangle, is the mouth of Lostland Run which empties into the North Branch of the Potomac River. The upper elevation of the watershed is comprised of the southeast flank of Backbone Mountain, a prominent topographic feature in the Garrett County area.

Lostland Run has been reported to have been a locally well-known stream for trout fishing prior to its pollution by acid mine drainage. Trout are still reported to inhabit the upper reaches of the stream. Lostland Run flows through and in close proximity to the Potomac State Forest for most of its length. This fact, coupled with the natural beauty of Lostland Run and the region through which it flows, would serve to make Lostland Run once again a trout stream of no minor consequence in the recreational schemes of the State of Maryland should the quality of the water be sufficiently improved.

North Prong And South Prong: The major streams which unite to form the main course of Lostland Run are the North Prong and South Prong Lostland Run. These two tributaries drain approximately 90% of the total watershed area.

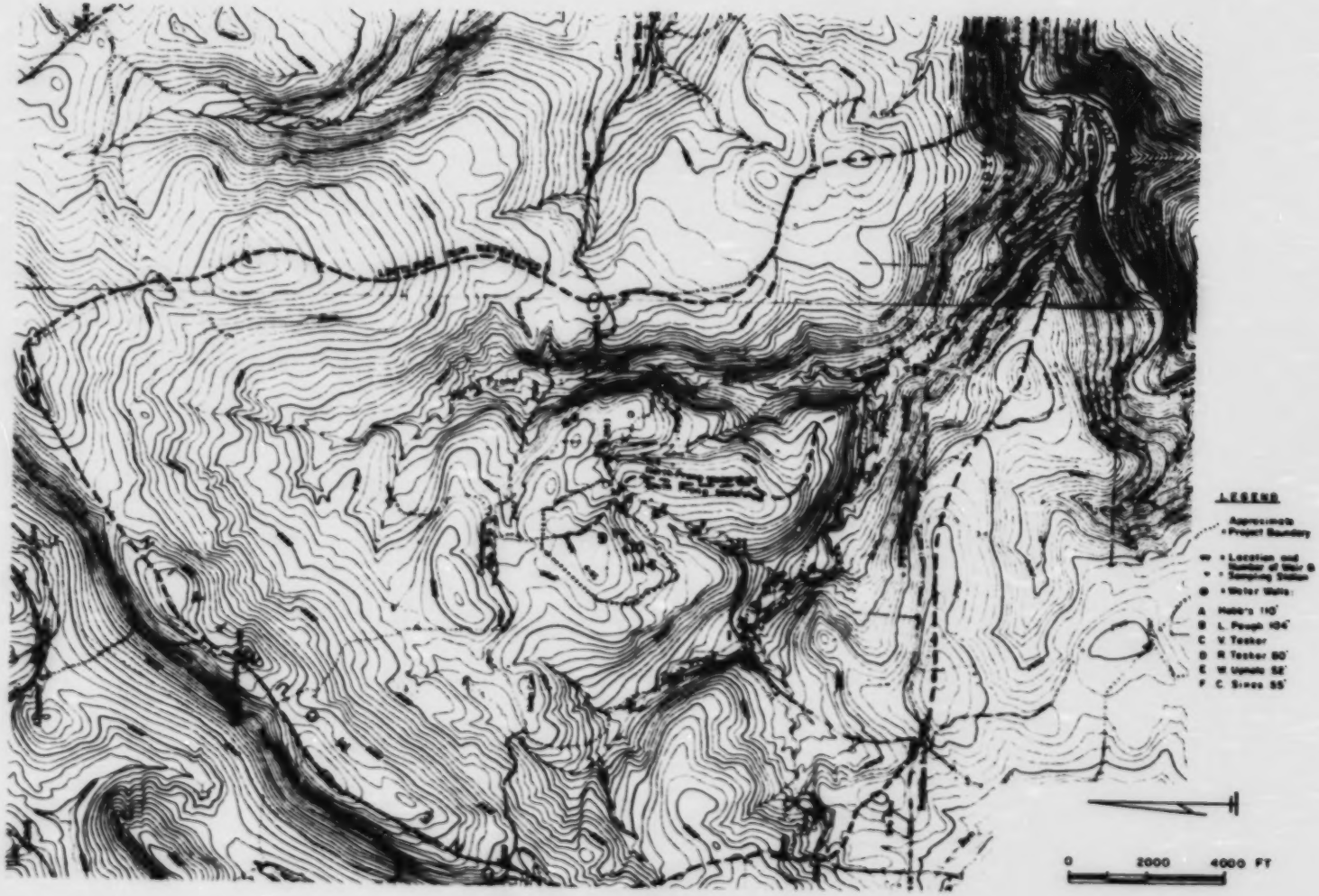

Figure 6 - WATERSHED MAP - SAMPLING STATIONS

Drainage from the project site occurs principally into an unnamed south-flowing tributary of South Prong Lostland Run. This stream enters South Prong Lostland Run at a distance of approximately 2-1/2 miles (4 kilometers) from where Lostland Run eventually enters the North Branch of the Potomac River. Little, if any, drainage is estimated to occur from the demonstration site directly or indirectly into the North Prong of Lostland Run.

Bloomington Dam: The Bloomington Dam on the North Branch of the Potomac River is now under construction by the U. S. Army Corps of Engineers. Flood control and low flow augmentation are the prime objectives of the impoundment of water.

One of the prime constraints on future use of the body of water for recreational and water supply purposes is the severe pollution of the North Branch of the Potomac River by acid mine drainage. While the impact of the daylighting project on the water quality of the North Branch of the Potomac River is not expected to be very great, neither will it be negligible. Lostland Run is a significant source of acid mine drainage pollution to the North Branch of the Potomac River. The completion of the project will eliminate an estimated 300 to 500 pounds (130 to 230 kilograms) per day of acid load to the North Branch of the Potomac River.

MINING IN WESTERN MARYLAND

Coal Basins: Bituminous coal has been extensively mined in Western Maryland. The coal occurs principally in five identifable and discrete basins, the Upper Youghiogheny Basin, the Lower Youghiogheny Basin, the Castleman Basin, the Georges Creek Basin and the Upper Potomac Basin. These basins are situated in Allegany and Garrett County, and generally have boundaries coinciding with boundaries of synclinal basins, separated by mountainous terrain. The approximate boundaries of these basins are indicated on Figure 4.

The most extensively mined of these basins and the one of greatest current activity is the Georges Creek Basin, located partly in Allegany County and partly in Garrett County. The other four coal basins extend into adjacent states of West Virginia and Pennsylvania, but the Maryland portions of these basins lie exclusively in Garrett County.

Upper Potomac Basin: The project site is situated in the Upper Potomac Coal Basin. This basin extends from the headwaters of the North Branch of the Potomac River to Piedmont, West Virginia. It is divided into two parts by the North Branch of the Potomac River, the northwestern portion being situated in Maryland. The Upper Potomac Basin is the second most extensively mined out area in the State of Maryland and is also the location of considerable current mining. Only limited mining is underway in the other three basins.

Coal Seam: The most important coals of the Upper Potomac Basin are found in the lower portion of the Conemaugh Formation and the upper portion of the Allegheny Formation. The Pittsburgh Seam which is at the base of the Monongahela Formation above the Conemaugh is reported over 20 feet (7 meters) thick near Elk Garden, West Virginia, but has been eroded for most of the Maryland portion of the basin.

With few exceptions, the various coal seams are poorly correlated in the five basins, with local and confusing names assigned to the coal seams. The Pittsburgh Coal ("Big Vein") has been extensively mined in the Georges Creek Basin where it attains a maximum thickness of 14 feet (5 meters).

The Barton Coal, the Lower Bakerstown Coal (or Thomas Coal) and the Davis Coal (Upper Freeport) are mined throughout the Upper Potomac Basin.

SECTION V

DATA OBTAINED DURING PHASE I

The following sections present the data obtained during Phase I and indicate the methods of obtaining these data. A physical description of the site and a plan showing existing topography are included. Data from the water quality monitoring, the test boring, the property ownership study, the study of mining at the site and the preliminary overburden nutrient analysis are presented.

DESCRIPTION OF THE PROJECT SITE

Figure 3 is an aerial photograph of the project site taken in November of 1972 from the Buffalo Coal Company Helicopter. The veiw is looking southwest with South Prong Lostland Run running parallel to the upper border of the photograph. Between the western boundary of the disturbed area and the border of the photograph, the mine being reclaimed along the west of the site is the Upole operation which should be completed before Phase II begins. The strip operation commencing at the sediment basin in the left foreground and proceeding clockwise around the left of the site is the current Buffalo Creek Coal Company operation. The Lower Bakerstown Coal is seen exposed at the base of the highwall left of the sediment basin.

TOPOGRAPHIC SITE PLAN

A detailed field survey was performed during Phase I. This field survey involved obtaining data from which to plot a plan of the project area. Cross-sections were obtained on 50 foot (15.2 meters) spacings across the project and plotted.

Figure 7 is a plan of the project area prepared from the detailed field survey. The existing spoil banks, strip pits, highwalls and deep mine entries located during the survey are shown on Figure 7.

Also, the location of the probable maximum original grade before stripping and the estimated original grade at other locations along the south of the project are indicated on Figure 7.

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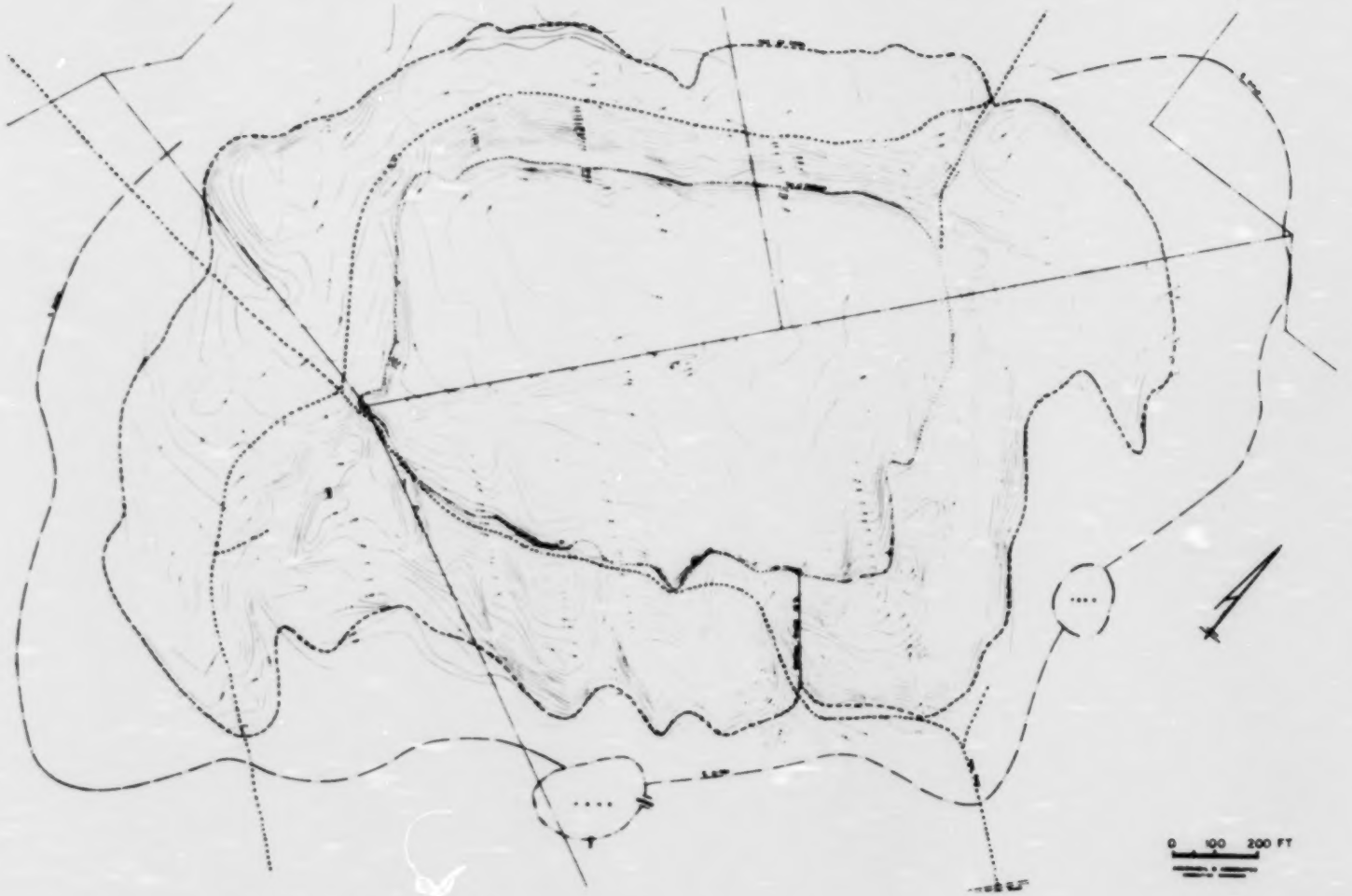


Figure 7 - TOPOGRAPHIC PLAN OF EXISTING SITE

WATER QUALITY STUDY

Watershed Reconnaissance: A preliminary watershed reconnaissance was undertaken on September 13 and September 14, 1972. Starting at the mouth of Lostland Run at its junction with the North Branch Potomac River, the stream was walked to the point at which the North Prong and the South Prong of Lostland Run meet. Both the North and the South Prong were walked from their confluence to their sources. Field pH was measured and water samples were taken at points where drainage entered the streams and at other key locations. The data obtained as a result of this survey are presented in the Appendix to this report. The following conclusions regarding the acid mine drainage pollution were based on the September 13, and 14, 1972 study:

Lostland Run discharges AMD into the North Branch of the Potomac River.

The principal source of this pollution is an abandoned deep mine just north of the bridge crossing the South Prong of Lostland Run. This mine is known locally as the Gilman Mine.

The Gilman Mine contributes most of thy pollution load to South Prong Lostland Run upstream of the entrance of discharge from the project site.

The pollution load of South Prong Lostland Run increases significantly below the entrance of discharge from the project site as shown on Figure 8 and Figure 9. The discharges from the site as measured at Station 7 indicate an average increase of 8% to a high increase of 16% during high flows.

The majority of the pollution load discharged by Lostland Run into the North Branch of the Potomac River originates on the South Prong of Lostland Run.

Phase I Monitoring: The monitoring stations at which routine samples were obtained weekly are shown on Figure 9. These sampling stations were established following the September 14 and September 15, 1972 survey and were based on the results of that survey.

Description of Sampling Stations:

Station 9, 10 and 14: Stations 9, 10 and 14 were established at definable locations with discharges from mining at the project site. Discharges at all three stations were estimated to originate from deep mines intersected by the strip mine highwall. While some water from the strip pits is present in the discharge, the majority of the flow is estimated to be deep mine drainage. 90°V notch weirs were constructed at these stations to enable an estimate of flow quantities to be made. No difficulty was encountered with maintenance of these weirs.

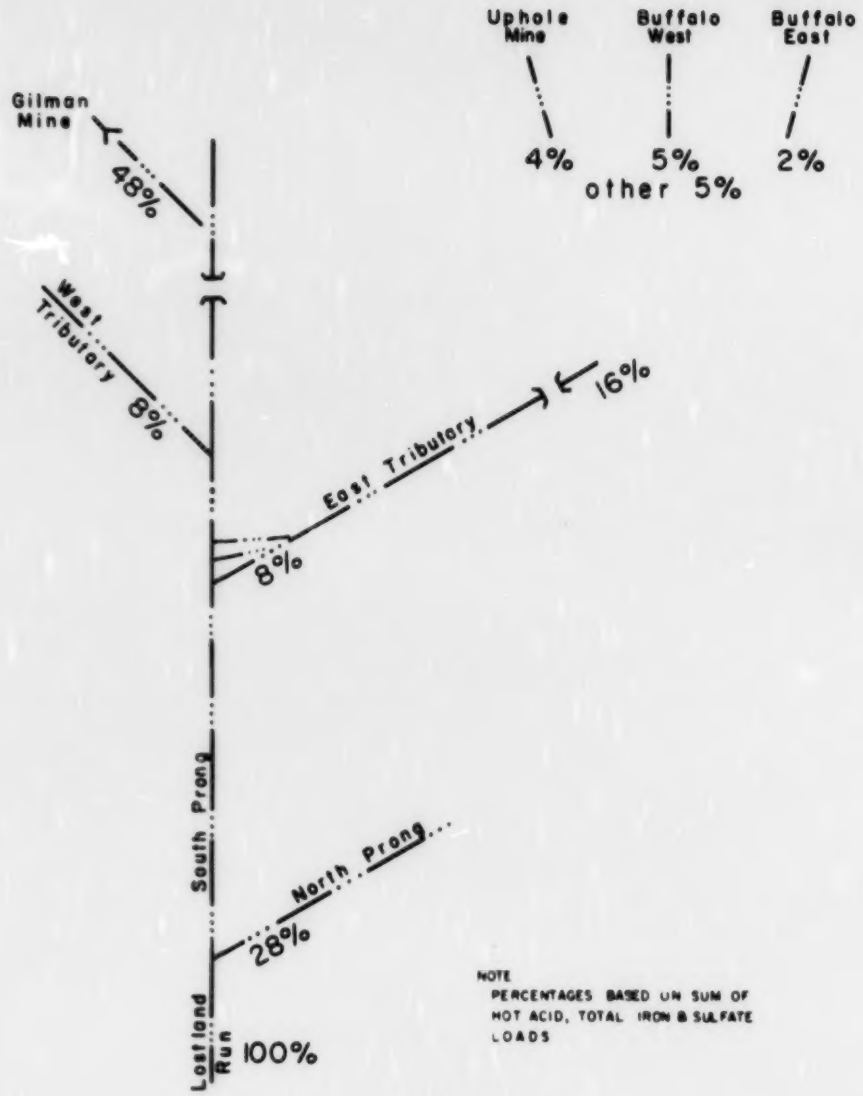


Figure 8 - SCHEMATIC SHOWING ESTIMATED POLLUTION SOURCES

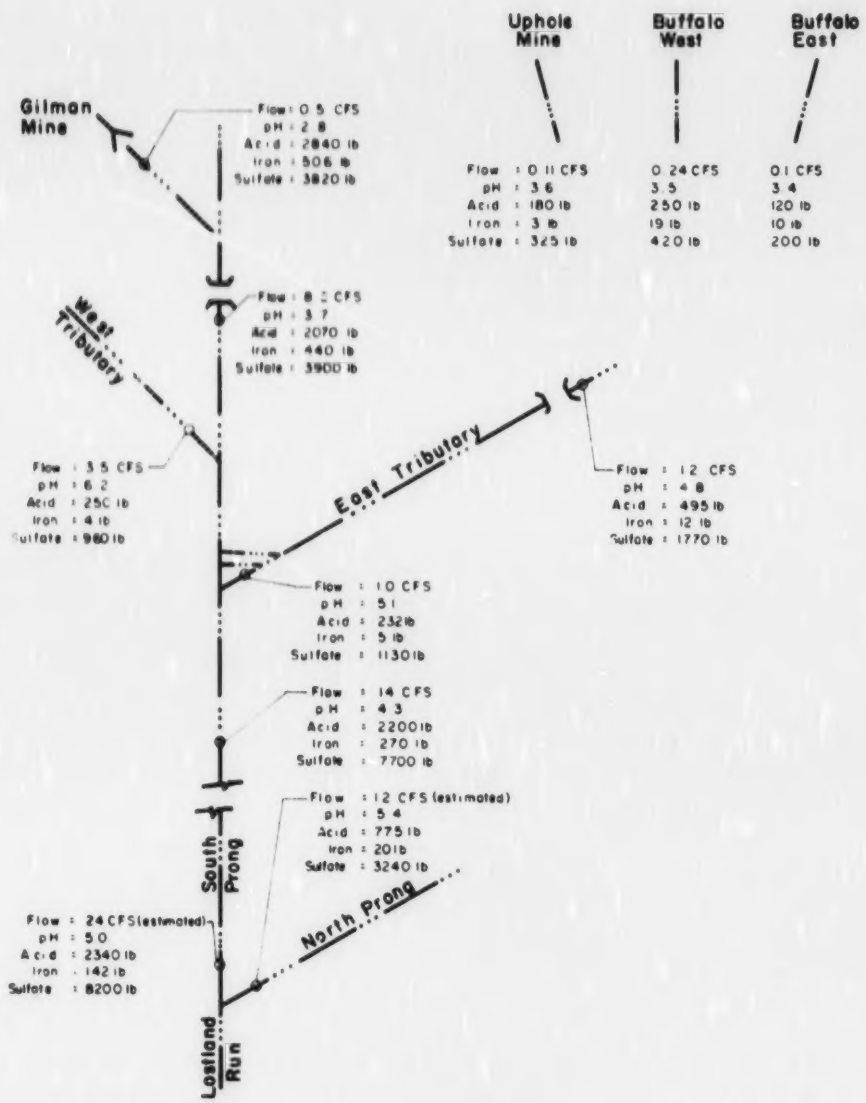


Figure 9— SCHEMATIC SHOWING ESTIMATED LOADINGS ON AVERAGE DAY

Station 8: Station 8 was established at the discharge location from the Gilman Mine. A 90°V notch weir was constructed to enable an estimate of flow quantities to be made.

Stations 1, 2, 3 and 4: Stations 1, 3 and 4 were located on the South Prong of Lostland Run. Station 2 is on the unnamed tributary entering South Prong of Lostland Run from the west just downstream of Station 1.

Horizontal weirs were established at these stations following the September 13 and 14, 1972 reconnaissance However, high water following heavy rains late in September and early in October resulted in weirs at Stations 1, 2 and 4 being washed out. These three weirs were re-established by pouring concrete abutments on both sides of the stream. A 2 inch (5 centimeter) wide groove from top to bottom of each abutment was formed to accept 2 inches by 12 inches (5 centimeters by 30 centimeters) planks which formed a weir across the stream. Sand bags were placed both downstream of the planks to provide support and upstream of the planks to inhibit underseepage.

Weirs, 1, 2, 3 and 4 washed out following a heavy rain the last week of November. Weirs 1, 2 and 4 were easily re-established by retrieving the intact planks and replacing broken planks. Weir 3 was abandoned at this time, since it was judged that the expense of re-establishment of this weir was not justified. It was felt that sufficient data could be obtained at the remaining stations.

Stations 7 and 11: Stations 7 and 11 are located at 18 inch diameter culverts leading beneath roadways. Flow quantities at these stations were estimated by recording the depths of flows in these pipes.

Stations 12 and 13: Sampling Stations 12 and 13 were established on the North Prong and the South Prong of Lostland Run at their junction. Flow quantities at these sections were estimated on the basis of surface velocity and assumed cross-sections.

Stations 5 and 6: Stations 5 and 6 were established at locations of identifiable discharges into South Prong of Lostland Run from the unnamed east tributary which is assumed to drain the site. The flows at these locations were only trickles.

Analyses: Samples were taken weekly at each sample station commencing on October 4, 1972. However, no good estimates of quantities were obtained on the west tributary or on the South Prong until November 21, 1972 due to construction and subsequent washing out of weirs. The information prior to November 21, 1972 is considered preliminary.

Water samples were obtained in glass bottles, rinsed in the source water before filling. These samples were promptly delivered to the State of Maryland Water Resources Administration Laboratory in Cumberland.

The following analyses were performed in the Cumberland laboratory:

Lab pH - Each Sample

Specific Conductance - Each Sample

Suspended Solids - Alternate Weeks

Dissolved Solids - Alternate Weeks

Turbidity - Alternate Weeks

Total Hot Acidity - Each Sample

Mineral Acidity - Each Sample

Total Iron - Each Sample

Ferrous Iron - Alternate Weeks

Aluminum - Alternate Weeks

Manganese - Alterante Weeks

Sulfate - Alternate Weeks

Total Alkalinity - Alternate Weeks

Total Hardness - Alternate Weeks

Settleable Solids - Selected Samples

Magnesium - Selected Samples

Calcium - Selected Samples

Results of Phase I Monitoring: The results of all water quality data are presented in the Appendix to this report. Table 16 presents the results of the September 13 and 14 watershed reconnaissance while Tables 1 through 14 are summaries of all the data obtained for each station during the regular monitoring program from October 4, 1972 to February 13, 1973.

Results of samples taken from November 21, 1972 to January 16, 1973 were used to prepare Table 15. These data represent estimated typical stream performance and pollution concentrations. The average pollution loads were based on the average concentrations of pollutants and the average flow observed during the November 21 to January 16 period. The use of weirs as a basis of quantity estimation was not available prior to November 21. Data obtained subsequent to January 16, 1973 were not available for inclusion in Table 15 at the time of its preparation.

Summary of Pollution Load Data: It is the opinion of the consultant that one of the best indications of the relative pollution at any source or at any sampling station would be the loadings of the principal pollutants, i.e., hot acidity, total iron and sulfates. Assuming that the summaries presented in Table 15 are reasonable, the averages of concentrations of hot acidity, total iron and sulfate were used with the average recorded or estimated flows to arrive at typical pollution loadings. These typical and average flows are presented on Figure 9.

Figure 8 is based on the sum of the hot acidity, total iron and total sulfate daily loadings as presented on Figure 8. The percentages shown are the percentages of the sum of the above pollution loadings with the pollution loading of Lostland Run just downstream of the confluence of the North and South Prongs taken as 100%.

In our opinion, the relative pollution loadings shown on Figure 9 reasonably represent the relative significance of the various sources.

With the total daily pollution load (as defined above) in Lostland Run below the confluence of the North Prong and the South Prong taken as 100% the following summary represents our opinion of the relative significance of each source:

Source	Contribution	Estimated Loading On An Average Day (Pounds)*
North Prong	28%	4,000
Project Site	16%	2,280
Gilman Mine	48%	6,850
West Tributary	8%	1,140

*Based On Sum Of Hot Acid, Total Iron and Sulfate.

Note: To convert pounds to kilograms, multiply by 0.4536.

INTERCEPTOR DITCHES AND SEDIMENT BASINS

In the water quality monitoring plan to be used during the daylighting project, ditches surrounding the site on the east, south and west sides are planned to intercept the estimated complete drainage from the site and conduct this drainage to two sediment basins or siltation ponds. These ditches and ponds were designed early in Phase I with the cooperation and approval of the Oakland, Maryland office of the U. S. Department of Agriculture Soil Conservation Service.

This system is planned to collect the discharge from the site before during and after mining and the continuous monitoring of discharge from the siltation ponds will provide data on which to base conclusions regarding the effectiveness in reduction of acid mine drainage from the site, the effectiveness of sediment control measures during construction and the effectiveness of post-construction erosion control measures.

The ditches were laid out and construction of the ditches and basins was begun the third week in October. Shortly after construction commenced, the weather became inclement with almost constant rain. It became impossible to work on the grading required to complete the basins and ditches and further construction during this phase was abandoned.

At this time the southern-most siltation basin, Pond #1, is rough graded and the ditches have been rough graded. No work has been accomplished on Pond #2. It is estimated that this phase of the work is 60% complete and will be completed with the approval of the State of Maryland early in Phase II to allow a short discharge base line to be established prior to beginning construction.

Consequently, the water quality study above is based on sampling of identifiable sources discharging from the site. Additional discharge from the site probably exists but is not being monitored until the discharge from the site passes into the east tributary. This tributary is monitored at Station II. (See Figure 6).

PROPERTY OWNERSHIP

Surface Rights: Figure 10 shows the boundaries of the site superimposed on the property ownership map. The bearings and distances of the bounds of the plot of ground required to contain the entire project are also shown. The surface rights to the land within the project are currently owned by six individuals. Daniel A. Holland, Clifton E. Holland, Reese Tasker and Harold H. Upole are the principal surface right owners involved while two small portions of land, belonging to Penzil Flowers and Alta J. Upole, also fall within the project boundaries.

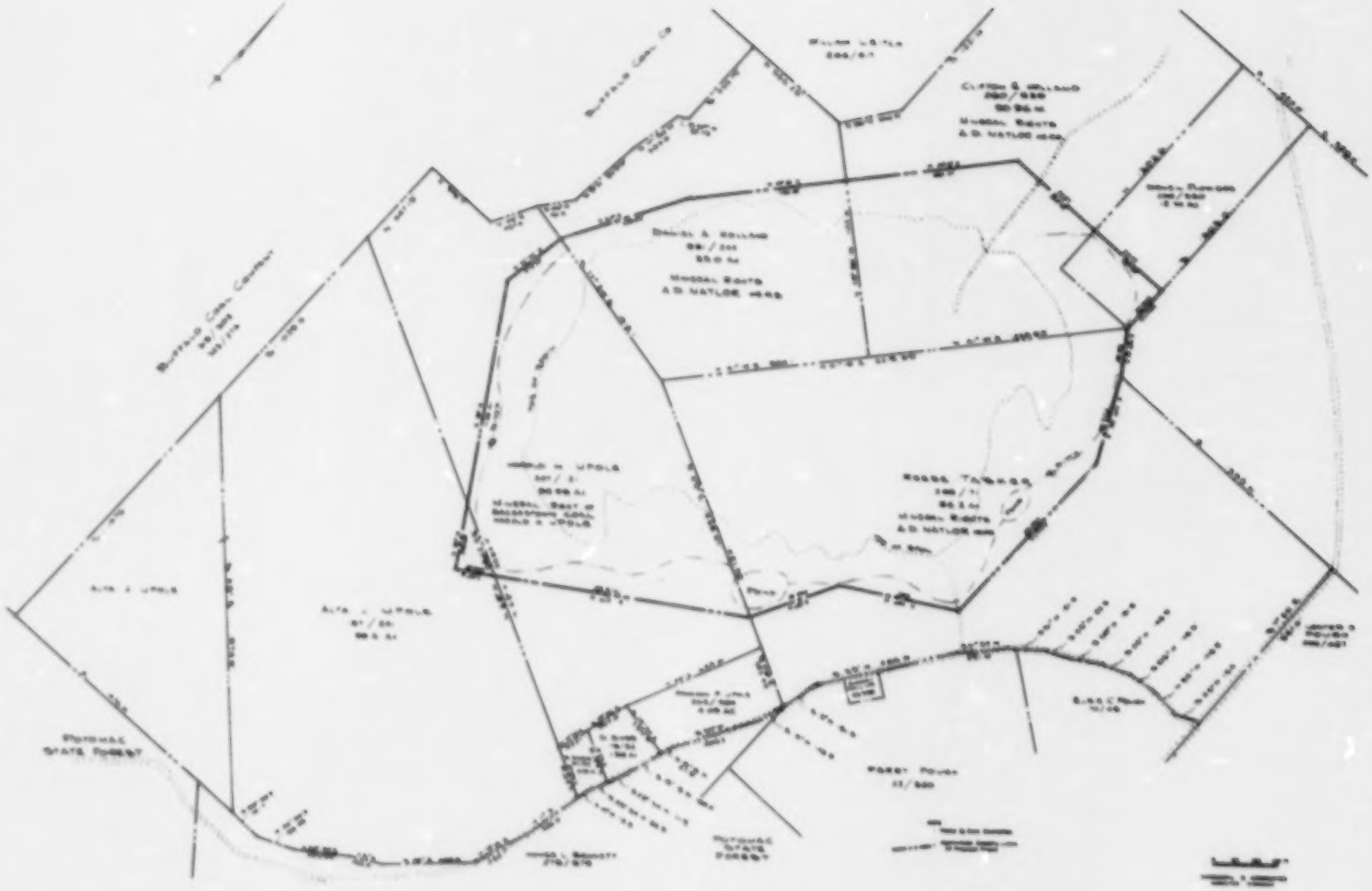


Figure 10 - PROPERTY OWNERSHIP MAP

Mineral Rights: Two mineral right ownerships would be involved within the area to be daylighted. The mineral rights below the Holland properties and the Tasker property are owned by A. D. Naylor Heirs. Harold A. Upole owns the rights to the Lower Bakerstown Coal and overlying minerals. It has not yet been determined who owns the rights to the minerals below the Lower Bakerstown Coal beneath the Harold A. Upole property.

GEOLOGIC SECTION AT THE SITE

Test Boring: One test boring was drilled at the location shown on Figure 9. This boring was drilled using diamond coring through rock with an NX core, by Tinney Drilling Company, Inc., of Bridgeville, Pennsylvania. The driller's log of this boring is included in the Appendix to this report.

Geologic Section: Figure 11 is a geologic section constructed from the results of this test boring. As shown on this section about 30 feet (9 meters) of soil overlies bedrock at the project site. Bedrock beneath the soil consists of about 20 feet (6 meters) of medium hard to hard gray shale, probably the Friendsville Shale, overlying the Lower Bakerstown or Thomas Coal. The Lower Bakerstown Coal was approximately 60 inches (1.5 meters) thick in the bore hole. About 3 feet (1 meter) of a brown underclay probably exists beneath the coal but this was not recovered. The brownish color was noted in the drill water during this 3 feet (1 meter) run. A massive gray shale was recovered to a depth of 82 feet (25 meters). From 82 feet (25 meters) to 104.5 feet (32 meters) a reddish shale, possibly the Meyersdale Red Shale, was encountered.

Massive gray shales were recovered to a depth of 152 feet (46 meters) where a 30 inch (76 centimeters) seam of coal was cored. This is estimated to be the Brush Creek Coal.

Hard dark gray shale was cored from a depth of 153.5 feet (46.8 meters) to a depth of 170 feet (52 meters). Thirty feet (9 meters) of a massive hard gray sandstone, estimated to be the Corinth Sandstone was encountered at a depth of 170 feet (52 meters).

The remainder of the boring was through gray shales until a hard black shale and coal was encountered at about a depth of 270 feet (82 meters). This formation is estimated to be the Piedmont Coal. The total thickness of hard black shale and coal encountered was about 4 feet (1.2 meters).

The material from a depth of 274 feet (83.5 meters) to 290 feet (88.4 meters) was soft to hard gray shale. At a depth of 290 feet (88.4 meters) a 4.5 foot (1.4 meters) thick stratum of a hard gray sandy shale with claystone streaks was encountered, followed by a 3 foot (1 meter) seam of coal, probably the Upper Freeport or Split Six Coal.

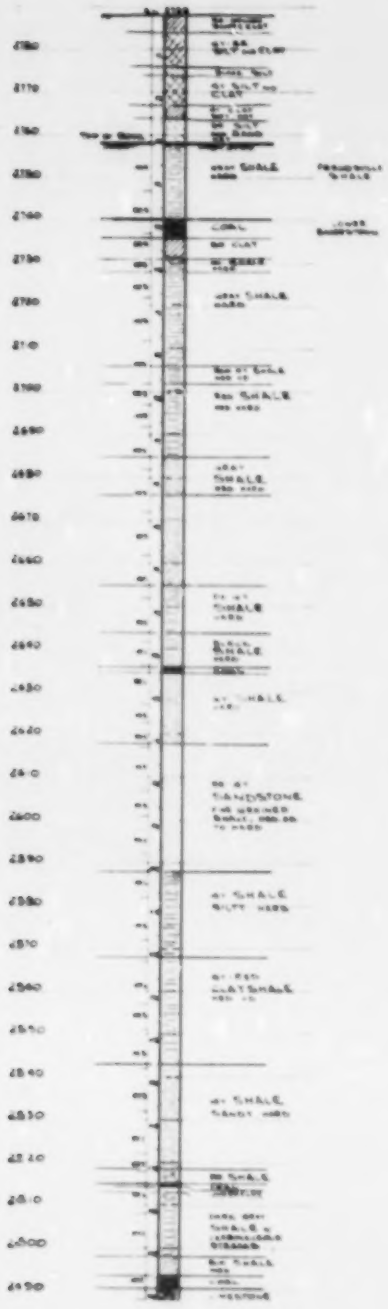


Figure II- GEOLOGIC COLUMN AT SITE

HISTORY OF MINING AT THE SITE

Source: No maps of any of the deep mine operations at the site were available for examination during this study. Previous owners and operators were contacted and the State of Maryland, Bureau of Mines files were searched without finding any maps of deep mining operations.

Local mine officials, persons formerly employed in the mining operations at the site, persons having a personal knowledge of the site history and local residents were interviewed. The approximate time and extent of mine operations described in subsequent sections are the results from these interviews.

Remaining Coal Reserves - Lower Bakerstown Coal: Remaining coal reserves underlying the unstripped areas of the site are estimated to be 30 to 35 percent. These estimates are approximate, however, because the extent of deep mine operations is not known.

Deep Mining: The historical data on mining of the site chosen for the EPA Daylighting Project began in the 1930's. At that time two individuals, a Mr. Briggs and a Mr. Martin, first names unknown, drove a drift entry on the property of Mr. Reese Tasker. The main entry ran approximately northwest with side rooms running northeast and southwest. The most extensive mining was done in a southwestern direction. It is reported that mining operations in the southwest were halted when a fairly large clay seam was intercepted. Mining along the direction of the main entry was believed to have been halted at the property line between Reese Tasker and Clifton Holland. It is believed that the Briggs and Martin mine was the only extensive deep mine on the Reese Tasker property.

From the mid-1950's to the mid-1960's several small deep mine operations were undertaken by various individuals. Three small prospect entries were driven on the property of Reese Tasker near the property line with William Upperman and Clifton Holland. The person or persons prospecting are unknown, but the mining is not believed to have been extensive. Mr. George Tasker operated a small deep mine on the Reese Tasker property immediately west of the existing Tasker home. In approximately 1960, a Mr. McCrosky, first name unknown, also drove two small entries west of the Tasker home, Figure 12.

In addition, Mr. Julian Moon (R. Shank) drove three entries on the property of Harold Upole. This mine is believed to have extended northeast toward the workings of Briggs and Martin to retrieve coal below the clay seam encountered by Briggs and Martin. During this same period, Mr. Wallace Kimmel drove a small entry from the coal face exposed by the surface mining done by Clay Stickell. This mine is also not believed to have been extensive with tunnels paralleling the Stickell highwall.

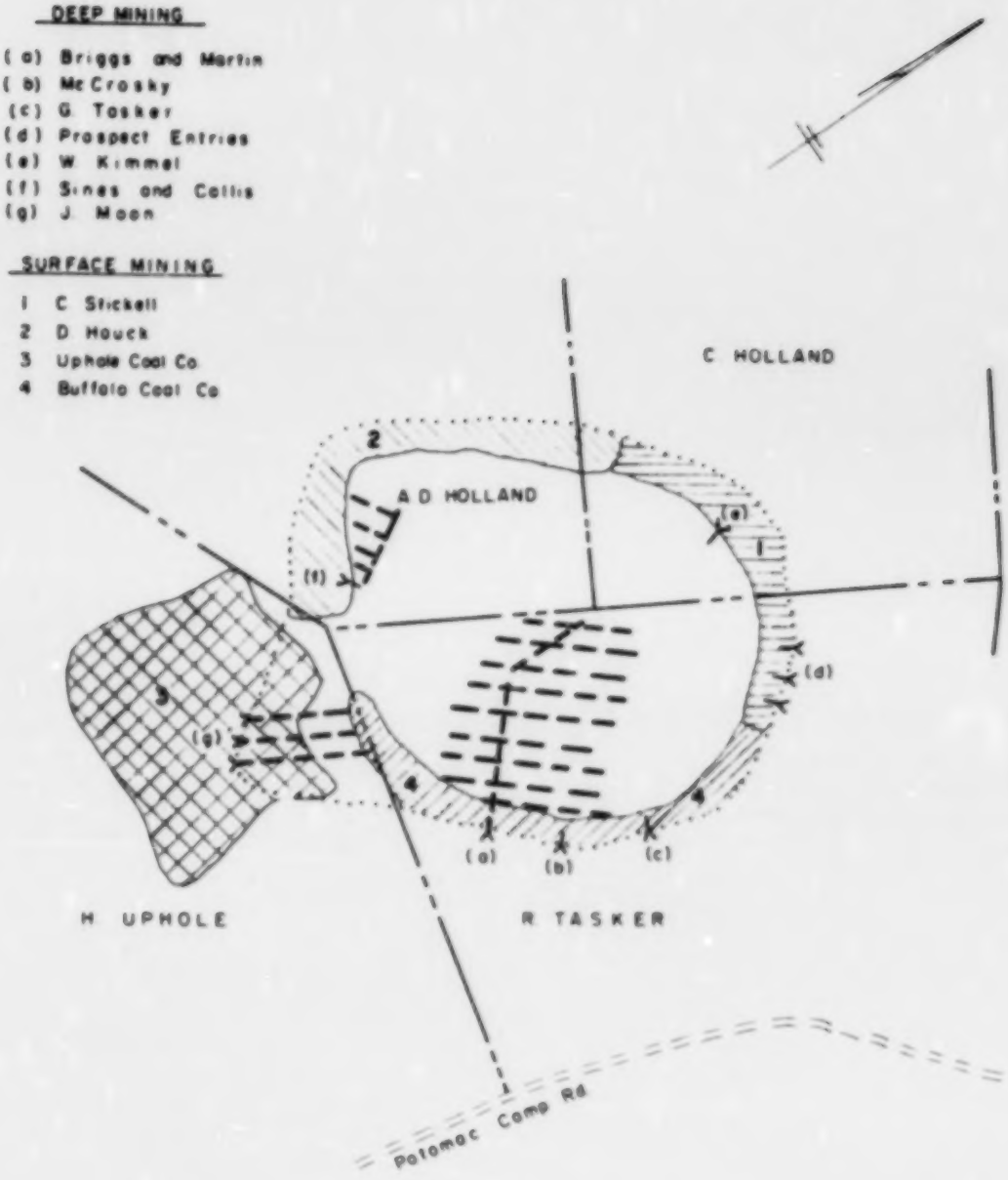


Figure 12 - SITE HISTORY OF MINING

Perhaps the most extensive deep mining during this period was done by Mr. Denzel Sines and Mr. Gordon Callis. Their entry was located on the property of Daniel A. Holland, adjacent to the property of Mr. Harold Upole and Mr. Reese Tasker, and ran approximately northeast. Rooms were driven northwest toward the surface mine pit of Daniel Hauck. Completion of mining by Mr. Sines and Mr. Callis concluded deep mining operations in the area. The approximate locations of these mines are shown on Figure 12.

Surface Mining: The approximate limits of the surface mining operations at the site are indicated on Figure 12. In the early 1940's, Mr. Clay Stickell began the first surface mining operations in the area. The mine was located on the property of Clifton Holland near the common intersection of that property with the properties of Reese Tasker and Penzil Flowers. The mining by Mr. Stickell was not extensive. The remainder of the surface mining of the properties of Clifton and Daniel A. Holland was done by Mr. Daniel Hauck. These surface mining operations were active in the latter 1950's with approximately 7,000 tons (6,350 metric tons) of coal being mined.

The most recent surface mine operations were undertaken by Upole Coal Company and Buffalo Coal Company. The operations of Upole Coal Company are located on the property of Harold Upole and affect a small area. This mine is operational to date. The operations of Buffalo Coal Company were located on the property of Mr. Reese Tasker. The Buffalo Coal Company operation is conducted under Permit #L14-67-195. This mining operation was temporarily halted in early 1972 by mutual agreement between the State of Maryland and Buffalo Coal Company when this site was considered for a daylighting project.

State of Maryland, Bureau of Mines Listing: The Maryland Bureau of Mines had the following list of operator's names and years of operation. However, they admit that the operator listed may be different from the actual people that operated the mines and also that the years of operation are only estimates. All of this mining was done prior to Maryland mining laws, except for current operators, Upole Coal Company and Buffalo Coal Company.

Briggs and Martin	1935
Clay Stickell	1942 -
Kimmel	1950 - 56
R. Shank	1952 - 56
Jordan and Foster	1956 - 59
Callis and Tasker	1958 - 62
Hauck	1959

McCrosky	1960 - 66
Tasker and Tasker	1962 - 63
Buffalo Coal Company	1971 - 72
Upole Coal Company	1971 - 73

Future Mining: No coal which would be stippable within the project boundaries or within reasonable proximity thereto exists below the Lower Bakerstown Seam.

A boring drilled near the high point of the site to a depth of 300 feet (91 meters) encountered two seams of coal. A seam approximately 18 inches (45 centimeters) in thickness, estimated to be the Brush Creek Coal, was encountered at a depth of 152 feet (46 meters) and a 36 inch (90 centimeter) thick seam estimated to be the Upper Freeport Coal, was encountered at a depth of 294 feet (90 meters).

It is estimated that recovery of either of these two coals by deep mining is not economically feasible at the present time.

Buffalo Coal Company is currently stripping two seams of coal, probably the above two seams, in the valley of South Prong Lostland Run, about 3000 feet (900 meters) west of the site. Upperman is stripping what is estimated to be the Brush Creek Coal in an operation substantially complete and has reclaimed about 1500 feet (450 meters) southwest of the project boundaries.

OVERBURDEN ANALYSES AND REVEGETATION POTENTIAL

Samples: Auger samples of soils encountered in the test boring were delivered along with the section of the rock cores to Dr. Richard M. Smith Professor of Agronomy at West Virginia Univeristy, Morgantown, West Virginia for analyses.

Summary Report On Overburden Potential: The summary of the overburden analyses and revegetation potential contained in Professor Smith's report is presented as follows:

> We have visited the site of this project, have observed the soil and rock section of the coal, have collected miscellaneous selected samples, have studied the test core provided by Ackenheil and Associates (labelled TB-1, or in W. Va. files Md.A) and have reached the conclusion that sufficient favorable material is available to form productive, non-toxic soil for a variety of possible uses and prevention of near-surface pollution by water or sediment.
>
> The overburden material is sufficiently variable with depth that placement for desired soil and water quality will require care.

Assuming that resistant coarse fragments (gravel, cobble and boulder sizes) will be undesirable at the land surface, it will be necessary to bury the topmost layer.

Two zones are potentially toxic from reduced sulphur compounds not over-compensated by basic constituents. These are associated with the Lower Bakerstown Coal and bone coal at 47 to 51 feet (14 to 16 meters) below the land surface at the point represented by the test bore; and by a recognizably dark colored zone (Munsell Color Value of 5 or lower) at the 12 to 14 foot (3 to 4 meter) depth below the land surface at the same location. Presumably, this horizon (35 feet (10.7 meters) above the Lower Bakerstown) corresponds to the Upper Bakerstown horizon of the region. The acid potential here is relatively minor and could be neutralized with potentially alkaline mudstones present elsewhere in the section.

Maximum carbonates (primarily calcite) occur in the gray shale (or mudstone) at 41 feet (12.5 meters) from the surface.

Between 21 feet (6.4 meters) (6 feet (1.8 meters) below the Upper Bakerstown Horizon) and 45 feet (13.7 meters) (2 feet (0.6 meters) above the Lower Bakerstown) sulphur contents range downward from 0.3 percent, which could cause toxicity except that sufficient neutralizing potential is present to assure net alkalinity throughout.

Decisions regarding detailed placement of materials for desired soil and water quality should be based on detailed information about available plant nutrients and textures of weathering mudstones represented as well as on the net acid-base accounts. Field clues could be developed to guide machinery operators in the choice of materials for planned placement.

Materials present in the overburden could accommodate a wide variety of plants and land uses. Ideal placement and treatment would be influenced by decisions about anticipated land use. For instance, surface cobbles and stones would be incompatible with efficient use of farm machinery as required on meadowland. On the other hand, they might be considered desirable in some woodland intended for recreation whereas high percentages of clay would be undesirable. But fertile calcareous mudstones would make productive meadowlands even through clay contents were relatively high.

Choices of plants would depend on land use and soil placements. However, a well-adapted forage mixture of general usefulness would be: birdsfoot trefoil 15 pounds (6.8 kilograms); white clover 5 pounds (2.3 kilograms); tall fescuegrass 10 pounds (4.5 kilograms) and redtop 5 pounds (2.3 kilograms).

Material between 21 and 45 feet (6.4 and 13.7 meters) below the surface is chemically favorable for plant growth without liming. Forage establishment and early growth would be favored by 500 pounds (560.2 kilograms/hectare) per acre of 15-15-0 fertilizer or equivalent. Other plant nutrients appear to be satisfactory.

SECTION VI

PROPOSED PLANS FOR PROJECT IMPLEMENTATION

MINING PLAN

Overburden Thickness: Figure 13 presents contours on the base of the coal. These contours are based on coal elevations obtained during surveying and on test boring information. In addition, Figure 12 shows isopachs of thickness from the base of the coal to the present ground surface.

Clearing and Grubbing: Approximately 30 acres (12 hectares) are covered by third growth timber and old spoil in which pine and fir trees (Christmas Trees) are growing. This area should be cleared, the marketable timber and pulp wood sold and the remaining brush slashed and buried or burned. Burning is recommended if permitted by Air Pollution Control Laws. If air pollution regulations prohibit burning, the slashed material should be buried as stripping progresses.

Stripping Topsoil: The upper 2 feet (6.1 decimeters) of topsoil material should be stripped from the 25 acres (10 hectares) more or less included within the existing highwalls. This material should be stockpiled in two areas.

Overburden Excavation and Coal Removal and Sale: The mining plan is indicated on Figure 14. It is anticipated that this operation will proceed in the following sequence:

Open Existing Keyway: The first step should be to open the existing keyway above Sediment Basin No. 1 as shown on Figure 14. This operation should be followed by a general grading of the existing pits left by the Buffalo Coal Company stripping. This general grading should be done to provide good drainage in the existing Buffalo Coal Company pits.

Cut Sequence: The mining should proceed in the sequence shown on Figure 14. The first cur should be around the west of the existing highwall as indicated by Cut 1. The small block of coal remaining to the southwest of the existing pit can be removed at any stage after Cut 1 has been made. This should be accomplished by Cuts, A, B, and C as indicated.

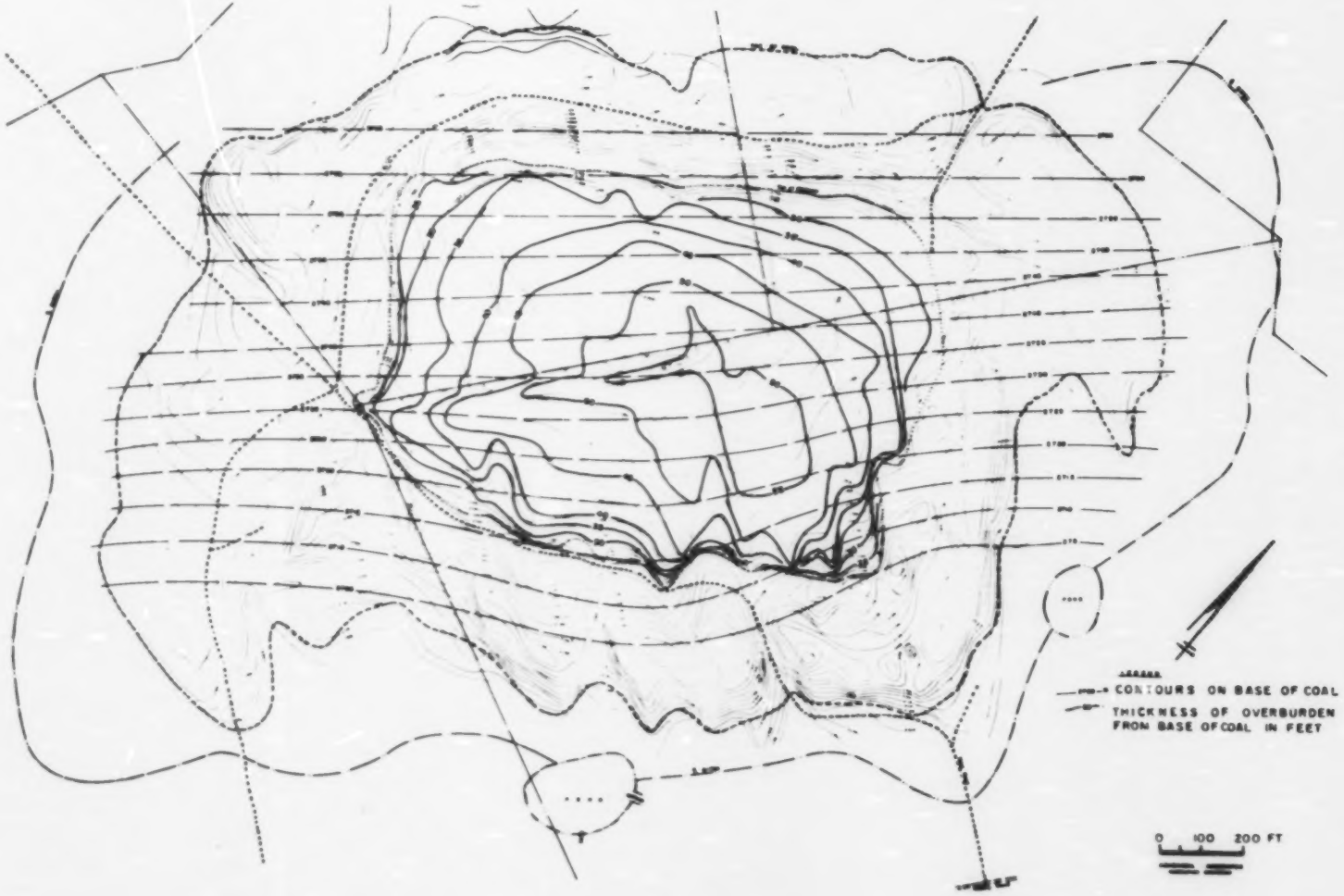


Figure 13 - COAL BASE CONTOURS and OVERBURDEN ISOPACHS

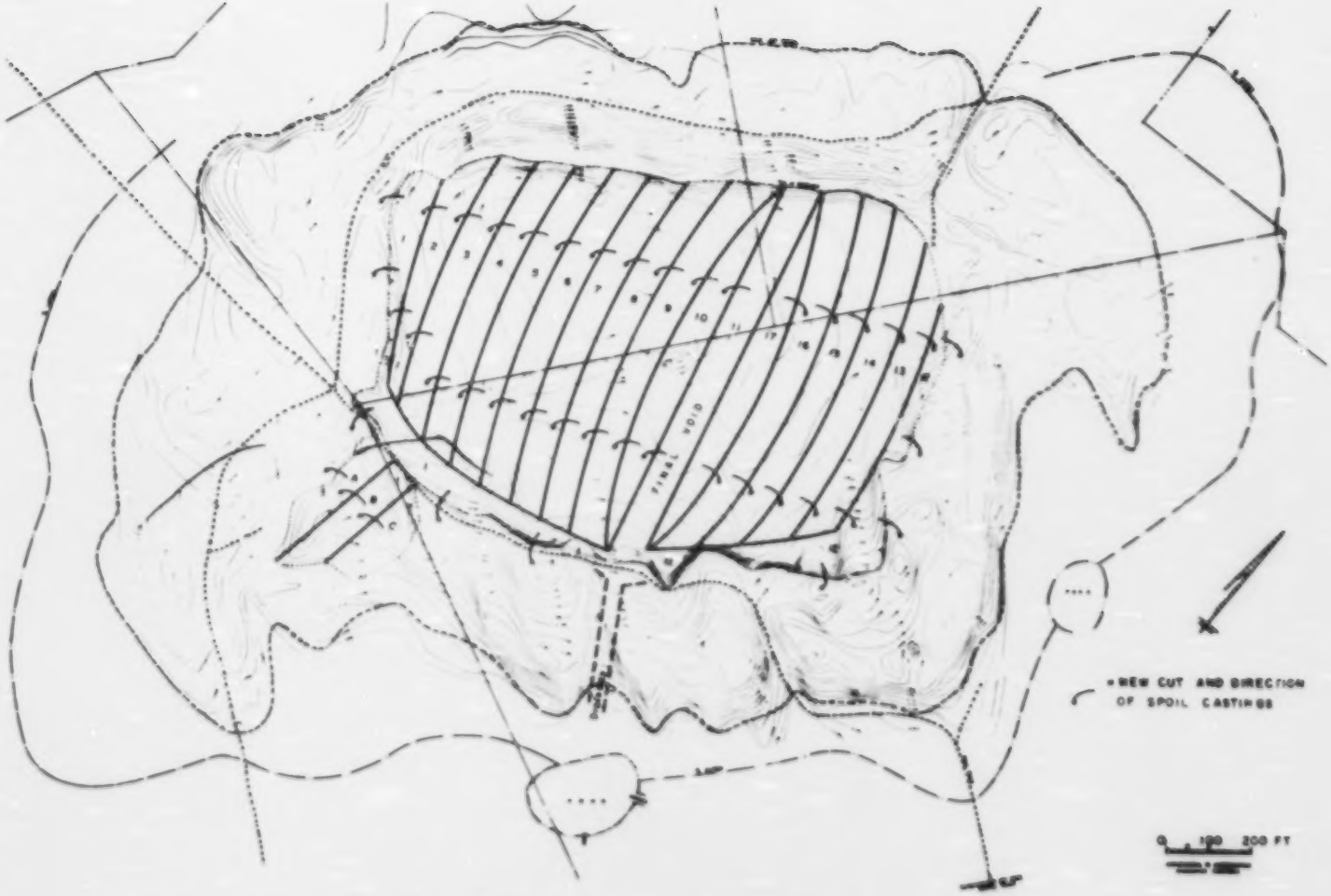


Figure 14 - PROPOSED MINING SCHEME

Either Cut 2 or Cut 12 could be taken next. If two sets of equipment are available, mining of the east of the site (Cuts 13 through 17) and the west of the site (Cuts 2 through 11) could proceed simultaneously. If only one set of equipment is available, the mining should progress in the exact numerical sequence indicated on Figure 14.

It is recommended that no equipment operate on top of the coal while removing the overburden. This is because of the danger of a shovel or other piece of equipment falling into the old mine entries and rooms. In addition, deterioration and contamination of the coal could occur if equipment worked on top of the coal. Either a high front shovel or a dragline could be used. However, not being able to operate on the coal and the necessity of being selective with the overburden material suggest that a dragline would probably be the more efficient piece of equipment.

Material Selection: During overburden removal, the material removed should be cast in such a manner that the upper 10 feet (3 meters) of the soil material existing above the gray shale bedrock is cast on top of the spoil. This requirement should present no difficulty to the operator since the materials are readily discernable on the basis of color and ease of excavation. The brownish soil material being removed can easily be placed on top of the gray shale material previously removed.

Toxic Material: The upper portion of the coal materials being removed represents the significant acid producing layer at the site. This material is potentially toxic to plant growth. As much of this material as possible should be mixed with the coal and sold. Any remaining material should be buried at the base of the spoil pile on the low wall side of the cut being made.

Coal: Analyses of the coal at the project site are presented on the table on the following page. As indicated from these analyses, the full 50 inches (1.3 meters) section of the coal is somewhat high in sulfur and ash and may or may not be marketable depending upon the market conditions at the time of mining.

Removal of the upper one foot of roof coal or bone coal will probably produce a product estimated to be similar to the Truck Top Sample reported in the following table. However, the bottom 30 inches (7.6 decimeters) of coal tested on March 31, 1972 was an exceptionally good grade of coal, low in sulfur and ash, and should yield a very good price.

At the time of mining, a marketing study should be made to determine whether sale of the entire 50 inches (1.3 meters) section of coal, sale of the section with the bone coal removed of the sale of the bottom 30 inches (7.6 decimeters) will produce the greatest return.

COAL ANALYSIS

Lower Bakerstown Coal

Buffalo Coal Company Strip Mine

Tasker Site

May 10, 1972 - Truck Top Sample

Moisture	2.03%
Ash	18.00%
Sulfur	1.37%
BTU	12409
	#9 Coke Button

March 13, 1972 - Channel Sample

	Full 50 in. (1.27 cm)	Bottom 30 in. (76.2 cm)
Moisture	2.66%	3.70%
Ash	25.19%	6.82%
Sulfur	3.65%	.67%
BTU	#8 Coke Button	#9 Coke Button

The Lower Bakerstown Coal is reported to be irregular in thickness and to contain at least one and sometimes several shale partings. As noted in the section discussing previous mining, the Briggs and Martin mine was reported to have been abandoned when a large clay seam was encountered.

Consequently, the quantity in place and the scheme for marketing the coal which will produce the greatest return can only be determined as daylighting progresses.

SITE RECLAMATION

Existing and "First Cut" Spoil:

Spoil on North: The existing spoil from the abandoned stripping around the north and northwest of the site should be pshed back into the adjacent abandoned strip pits. Thisoperation probably can best be accomplished as the successive strip cuts indicated on Figure 14 reach their northern limits. At that time the existing spoil can be pushed into the abandoned strip pit and the dragline can deposit soil material being excavated over this spoil.

Spoil on East and South: Any "orphan" gob or bone piles on the north and northeast periphery of the project site should be panned into the central void left at the completion of cuts 11 and 17 as shown on Figure 14.

The abandoned spoil to the east of Buffalo Coal Company's operation and the spoil from the Buffalo Coal operation and from Cuts 1 and 12 should be removed by pan or scraper and also deposited in the central void left at the completion of daylighting. Panning this material into the central void should result in the potentially toxic material in this spoil being buried and the original upper soil material ending up once again on top.

Final Site Plan: A recommended final site plan is presented in Figure 15. This site plan endeavors to restore the original topography. The suggested site plan also is compatible with the previously recommended scheme for daylighting and disposing of existing spoil.

Maximum Slopes: The maximum original slope occurred at approximately the section indicated on Figure 15 and is estimated to have been about 23% (13°). The recommended final plan has final slopes along the south of the project site about 20% (11-1/2°).

Land Useage: The recommended final plan is compatible with a range of future land use. It is particularly favorable to agricultural useage since considerable, reasonably level land is provided. As topsoil development and enrichment occur, conversion to forest land would be possible.

Grading Plan: Following completion of the mining or daylighting operation and the removal and burial in the central void of existing spoil, the following sequence of grading operations is suggested:

Regrading of reclaimed Upole Mine with excess material graded to the approximate location of the Buffalo Coal Company strip pits.

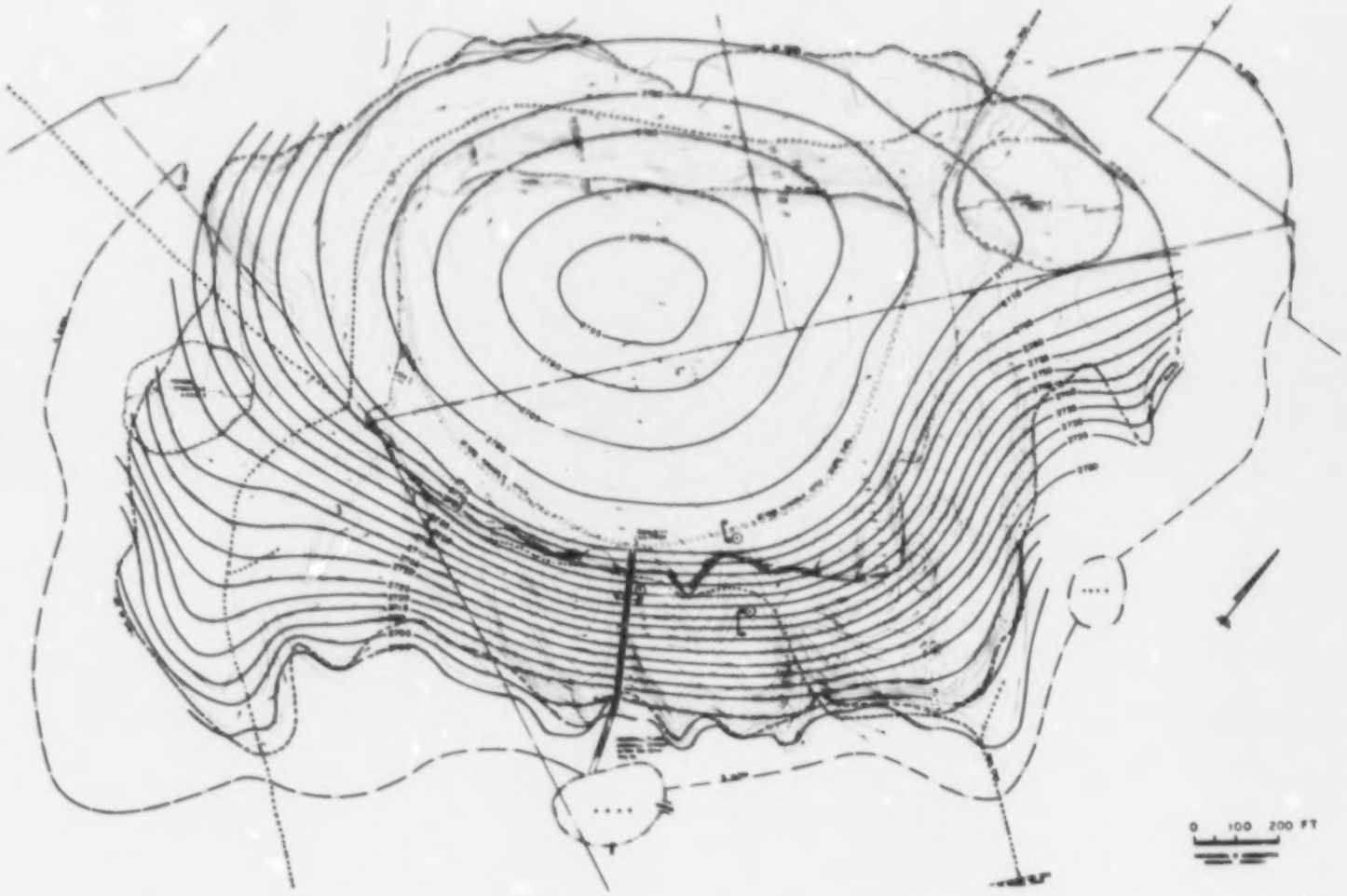


Figure 15 - PROPOSE FINAL PLAN

Reproduced from best available copy.

Grading of the northwest, north and northeast peripheral areas, grading any excess material toward the approximate previous locations of the Stickell and Hauck strip pits (See Figure 12) to contours shown on Figure 15.

Grading of area daylighted to contours shown on Figure 15. This grading should be performed in such a manner that the soil material is spread over the top surface.

Distribution of stockpiled topsoil on all areas outside of the original highwall locations and grading of these areas to contours shown on Figure 15.

Erosion Control: Particular control measures are necessary to reduce erosion on the southern slopes of the reclaimed area. The following are recommended:

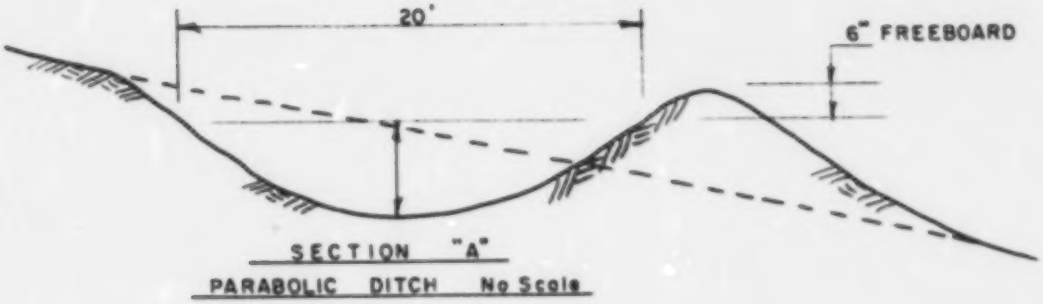
A diversion ditch at the top of slope as shown on Figure 15 is recommended. This ditch should be 20 feet (6.1 meters) wide and have a parabolic cross-section as shown in Figure 16.

A riprap section at the location indicated on Figure 15 and having the section shown on Figure 16 should be constructed to carry the discharge from the parabolic diversion ditch to the ditch leading to the sedimentation basin.

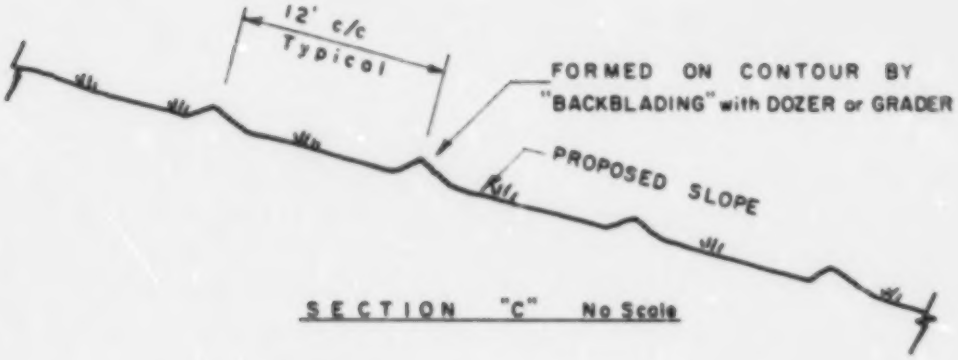
Fine grading the slope to produce ridges of earth at approximate 10 feet (3 meters) spacings following the contours is recommended. A section of this slope is shown on Figure 16. All equipment working on this slope should follow the contours. Formation of the earth ridges and final grading should be accomplished by back-blading to remove depressions by the grousers on the dozer treads perpendicular to the contour formed.

Soil Amendments: The surface shall be prepared, lime (if required) and fertilizer spread and the surface disced following the contour exactly. The amounts of lime and the fertilizer specification will be recommended following more detailed studies made by Professor Smith at the Univeristy of West Virginia as the mining progresses. For preliminary estimating purposes, Dr. Smith's tentative recommendation of 500 pounds per acre (560.2 kilograms per hectare) of 15-15-0 fertilizer with no liming required was used

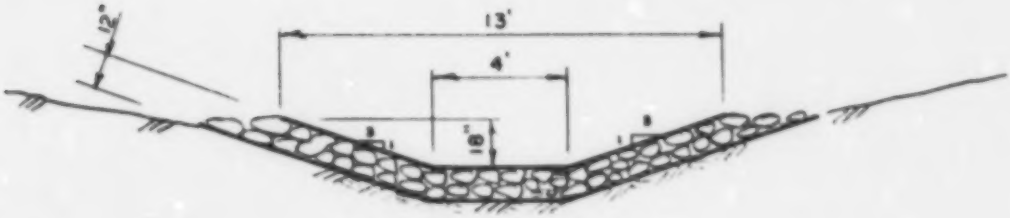
Seeding and Mulching: One of the seeding mixtures included on Page 3.903 of the proposed "Standards and Specifications for Seeding Strip Mine Areas in Western Maryland" included in the Appendix to this report should be selected. This selection will be dependent upon the planting season. The planting should be accomplished according to the Specifications. Mulching and mulch anchoring should follow the proposed Specifications. Hay mulch is recommended if obtainable and if free of noxious weeds such as Canada Thistle, Johnsongrass and Quackgrass.



SECTION "A"
PARABOLIC DITCH No Scale



SECTION "C" No Scale



SECTION "B"
RIPRAP SLOPE PROTECTION
No Scale

Figure 16 - MISCELLANEOUS DETAILS

CONTINUING WATER QUALITY MONITORING

Stations on Lostland Run: It is recommended that the present sampling stations on Lostland Run be relocated and improved by establishing permanent stream flow gaging stations at the following locations:

On South Prong Lostland Run, just downstream of the mouth of the unnamed west tributary.

On South Prong Lostland Run, just upstream of the mouth of North Prong Lostland Run.

On Lostland Run just upstream of the North Branch of the Potomac River.

These gauging stations should be designed and calibrated to give continuous recordings of stream flow quantities at these locations.

Water Quality Sampling on Lostland Run: As soon as the above three stream gauging stations are established, the program of weekly sampling should be reinstituted.

Purpose of Lostland Run Sampling: The purpose of the three stations on Lostland Run is to determine the project impact. The stations above and below the source will indicate changes in pollution load during and following project implementation.

The station at the mouth of Lostland Run will indicate the effect of the project in reducing the pollution load discharged by Lostland Run into the North Branch of the Potomac River.

Monitoring of Site Discharge:

Continuous Monitoring: It is recommended that a continuous, automatic recording water quality and flow quantity monitoring station be established on the discharge of Sediment Basin No. 1 and that an automatic recording flow quantity monitoring gauge be established on the discharge of Sediment Basin No. 2. It is felt that, with the mining and grading plan recommended, only a minor quantity of water will enter Sediment Basin No. 2 and the detailed grading plans will provide for the extension of the drainage collection ditch across the haul road to connect with the ditch which extends east of Sediment Basin No. 1. This will result in the ultimate abandonment of Sediment Basin No. 2.

Weekly Samples: It is recommended that, in addition, weekly water quality samples be obtained at the discharges of the two sediment basins. These should be taken concurrently with the samples on Lostland Run.

Analysis of Weekly Water Quality Samples: The five weekly grab samples from the three stations on Lostland Run and the sediment basin discharges should be analyzed for the following physical and chemical properties:

Physical Properties: Temperature, Turbidity, Total Solids, Filterable Solids

Chemical Properties: pH, Total Acidity, Mineral Acidity, Alkalinity, Total Iron, Ferrous Iron, Sulfate, Aluminum, Calcium, Manganese, Magnesium

Automatic Monitor - Sediment Basin:

Stage Recorder: The discharge from the standpipes of both sediment basins should discharge into a poured concrete basin filled with a V-notch weir. The water levels in these basins should be monitored with continuously recording stage gauging instrumentation.

pH and Conductivity: The discharge from Sediment Basin No. 1 should be automatically monitored for pH and conductivity with continuously recording instruments.

PROPERTY ACQUISITION AND CONTRACTUAL CONSIDERATIONS

Acquisition of Surface and Mineral Rights: The policy of the "Abandoned Mine Drainage Program" of the State of Maryland is to acquire ownership of both surface and mineral rights to any property involved in a project or obtain easements as previously described. Hence, the first step in implementation of the Daylighting Project will be to acquire property ownership and/or obtain easements. No negotiation, contract or work can commence before ownership or easements are required. Currently, a negotiator for the State of Maryland is in the field investigating this factor.

Contract: One of the more difficult factors in implementation of this project will be arriving at a contract that meets the approval of both the State of Maryland and the Environmental Protection Agency that yields a reasonable, but not excessive, profit to the contractor selected to do the work.

Most of the earthmoving, grading and revegetation quantities can be estimated within reasonable limits prior to construction. Thus, the costs for most items can be reasonably estimated at the time of contracting. The major unknown factors which quite significantly influence the net cost of the project are the quantity and selling price of the coal. Arranging for a contract which will consider these factors, which will assure the State of Maryland that the construction budget will not be exceeded and which will not result in either loss or excessive profit to the contractor will be very difficult. The following possibilities for reaching a contract arrangement for the Daylighting Project are suggested:

Bid on Lump Sum Basis: In this type of arrangement, the construction contract would be let on the basis of a lump sum cost for the entire job. The contractors bidding on the job would arrive at their own estimate of the coal remaining in place and would estimate the average selling price for coal over the life of the mining phase of the project. On the basis of these estimates, contractors would bid one lump sum figure for the complete job and the contract would be awarded to the lowest bid of a qualified contractor. Under this arrangement, the contractor would lose or gain if the quantity of coal still in place varied from the estimate or if the selling price of coal fluctuated.

Advantages: The advantages of such an arrangement are that the contract is let following competitive bidding, the State of Maryland is assured of the cost of the project and careful and continuing monitoring of material quantities is not needed for payment.

Disadvantages: The major disadvantages of such an arrangement is that costs for various work items would be difficult to account for and separate. Since the study of costs is one of the objectives of the proposed project, this is a major disadvantage. In addition, the contractor could end up with an inordinately high profit which could lead to public criticism of the project.

Bid on Lump Sum Basis for Construction Only: In such an arrangement, contractors would submit a lump sum bid price for all work items. The qualified contractor with the lowest lump sum bid price for the sum of all construction items would be awarded the contract. The State of Maryland would arrange separately for the sale of the coal. The monies acquired for the sale of the coal would be applied to payment of the contractor.

Advantages: The State of Maryland would benefit from any recovery of coal in excess of the quantity estimated and from any increase in the sale price of coal over the life of the project. There would be no opportunity for public criticism on the basis of the contractor making an inordinately high profit.

Disadvantages: The principal disadvantages of this arrangement are that no unit costs would be directly obtainable and that the total net cost of the project could vary and would be difficult to predict. The obtaining of unit costs is one of the principal objectives of the project. In addition, the State of Maryland would have to make all arrangements for sale of coal, and accept the possibility of the net cost of the project exceeding the budgeted amount.

Bid on Unit Price Basis: In this type of arrangement, contractors bidding on the job would submit unit prices for the various items of work. The contract would be awarded to the qualified contractor whose unit prices bid yielded the lowest estimated cost for the construction based on estimated quantities furnished by the Engineer. The State of Maryland would arrange for and benefit from the sale of the coal. Such monies would be placed in a separate account and applied to the payment of the contractor's charges for the project.

Advantages: This could result in the lowest cost of the project to the State of Maryland based on the possibility of recoverable coal in excess of estimated quantities and a continuing increase in the selling price of coal. It would preclude the realization of an excessive profit by the contractor. An arrangement of this type would satisfy one of the prime objectives of the project by furnishing relatively accurate cost data.

Disadvantages: The basic disadvantage of such a contract would be the inability to predict the final cost of the project before the project was completed. The total project cost could be considerably above estimates, should the selling price of coal drop drastically or should some unforseen factor reduce the quantity of recoverable coal significantly below the estimate.

Bid on Cost Plus a Fixed Fee Basis: This arrangement would be a variation from the above in that unit costs for the various construction items would be submitted in lieu of unit prices. An additional bid item would be the contractor's fixed fee for performing the work. The contractor would arrange for the fee for performing the work. The contractor would arrange for the sale of the coal but the money recovered from this sale would be held in an account and applied to payment of the contractor's cost and fee.

Advantages: An arrangement of this type would have the advantages of the unit price arrangement. In addition, the State of Maryland would be relieved of involvement in the sale of the coal. There is a possibility that lower unit costs might be bid because the contractor's fee would not be tied to the quantities involved. The job might be completed in less time since the contractor's percentage profit would increase with decrease of costs resulting from reduction in construction time. Any decrease in total construction time would result in a decrease in costs for engineering field representation.

Negotiation: A construction contract could be awarded following negotiation with a single contractor on any of the preceding bases. In addition to the advantages and disadvantages noted previously, the following points should be noted:

Advantages: Possibly lower unit prices or unit costs could be obtained. Buffalo Coal Company, who submitted a letter of intent with the original project application, has an existing contract with Virginia Electric Power Company for coal. Therefore, new arrangements would not be necessary for coal sale, should the Buffalo Coal Company complete successful negotiations with the State of Maryland. Buffalo Coal Company has a stripping operation in close proximity to the project site and has a more favorable position since moving and mobilization costs would be less. The possibility of some "good will" contribution by Buffalo Coal Company exists. Buffalo Coal Company has cooperated fully during Phase I and indicated a willingness to contribute significantly to the project during the application stage.

Disadvantages: The two principal disadvantages to negotiating would be that comparative unit prices or unit costs would not be available. Unless a complete audit of Buffalo Coal Company were undertaken, the actual cost might be hard to determine. Obtaining relative cost data is one of the prime objectives of the project. Secondly, the contracting regulations of both the Department of General Services of the State of Maryland and the Grants Administration Division of the Environmental Protection Agency may make a negotiated contract on such a sizeable project impossible.

TIME SCHEDULE

Proposed Time Schedule: A preliminary time schedule is presented in Figure 17. This time schedule is based on mining progressing one cut at a time. It provides for final planting within a planting season. This schedule could be revised by construction using two sets of equipment and making simultaneous cuts. The time schedule is tight and indicates the necessity to proceed promptly with contract negotiation, land acquisition and construction.

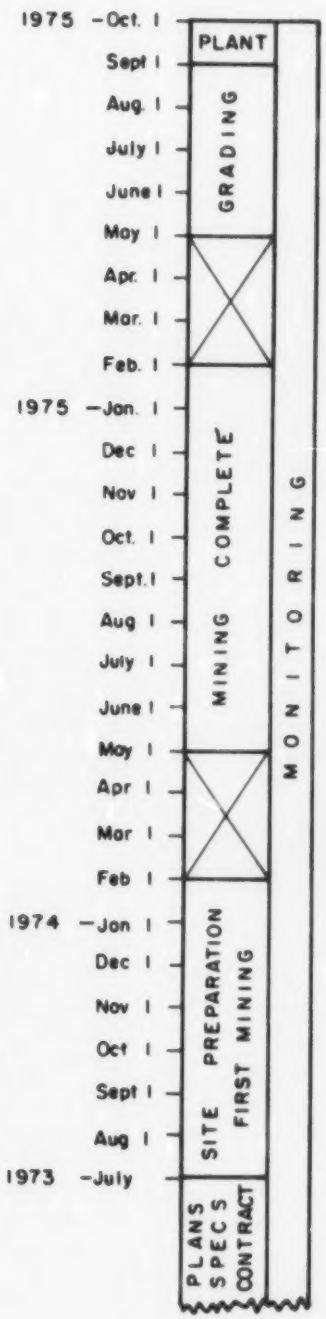


Figure 17 - PROPOSED CONSTRUCTION SCHEDULE

SECTION VII

COST ESTIMATE

SUMMARY OF ESTIMATED COSTS TO COMPLETE PROJECT

Mining and Reclamation:

Estimated Cost:	$476,760.00
Minus Credit For Coal Sale	-191,000.00
Minus Credit For Required Reclamation	- 4,500.00
Estimated Net Cost	281,260.00
Water Analyses	6,450.00
Additional Soil Nutrient Analyses Phase II and Phase III	3,800.00
Engineering Plus Fees (Including Stream Gauging Stations ($2,300.00) and Sediment Monitoring Stations ($4,460.00)	191,225.00
TOTAL OF ABOVE ITEMS:	$482,735.00

Phase II and Phase III State of Maryland Salaries and Expenses are not included in the above total.

There will be a carry-over to Phase II of the $10,000 budgeted in Phase I for construction of the sediment ponds and interceptor ditches.

MINING AND RECLAMATION

The following table contains the estimated quantities and approximate unit costs for the various items necessary in daylighting and reclamation. The unit costs used are based on bids received on Quick Start Projects in Pennsylvania and discussions with persons familiar with mining and reclamation in western Maryland.

ESTIMATE OF QUANTITIES AND COSTS

Item	Estimated Quantity	Estimated Unit Price	Estimated Price
Clearing and Grubbing	30 Acres	$75.00	$ 2,250.00
Strip and Stockpile Topsoil	88,000 Yds.^{3}	$ 0.50	44,000.00
Overburden Removal	1,460,000 Yds.^{3}	$ 0.23	336,000.00
Distribute Old Spoil	234,000 Yds.^{3}	$ 0.20	46,800.00
Grading	70 Acres	$100.00	7,000.00
Spread Topsoil	88,000 Yds.^{3}	$ 0.25	22,000.00
Parabolic Ditch	1,820 Ft.	$ 0.50	910.00
Additional Grading On Slopes (Ridge Formation)	35 Acres	$100.00	3,500.00
Riprap Section	380 Ft.	$10.00	3,800.00
Fertilize, Disc, Seed & Mulch	70 Acres	$150.00	10,500.00
Total Estimated Cost Of Mining And Reclamation:			$476,760.00

NOTE: To convert acres to hectares, multiply by 0.4047.
NOTE: To convert feet to meters, multiply by 0.3048.
NOTE: To convert cubic yards to cubic meters, multiply by 0.7646.

It is estimated that construction of interceptor ditches and sedimentation basins can be completed within the amount budgeted in Phase I ($10,000).

GAUGING STATIONS

The costs for the three gauging stations is estimated to be $2,300 using the following estimated costs for materials and labor.

COST PER STATION

Description	Estimated Cost
4 Ft.-36 in. (1.2 Meters - 91.4 Centimeters) Corrugated Steel Pipe At $24.00/Ft. (30.5 Centimeters)	$ 96.00
Automatic Stage Recorder	$300.00
Station Enclosure	$100.00
Riprap	$ 30.00
Labor	$240.00
TOTAL COST PER STATION:	$766.00

Thus, the estimated cost of 3 stations is: 3 x $766.00 = $2,300.00

WATER QUALITY STATIONS AT SEDIMENT BASINS

Sediment Basin No. 1: It is recommended that a stilling basin be constructed at the outfall of the discharge of Sediment Basin No. 1 and that an automatic continuously recording station measuring stage, pH and conductivity be installed. The estimated cost of this installation is as follows:

Stilling Basin and Station Enclosure Construction	$ 880.00
pH Probe and Instrumentation	$ 600.00
Conductivity Probe and Instrumentation	$1,500.00
Automatic Stage Recorder	$ 300.00
TOTAL ESTIMATED COST:	$3,280.00*

*Assumes the enclosure for the instruments will be furnished by EPA.

Sediment Basin No. 2: Since it is estimated that only a small portion of drainage from the site will enter Sediment Basin No. 2 and since early abandonment of this Basin is anticipated, it is not recommended that pH and conductivity instruments be installed. Hence, the total estimated cost is $1,180.

WATER ANALYSIS

Phase II: Assuming that the daylighting project proceeds according to the schedule presented in Figure 19, sampling and analyses will be required for a total of 27 months or 120 weeks. Thus, a total of 600 analyses will be required during this phase of the project.

Phase III: The Phase III or Post-Daylighting monitoring will be continued for a 12 month or 52 week period. Thus, 260 analyses will be required during this phase.

Estimated Costs: Recent studies in the Cumberland Lab of the Maryland Water Resources Administration have resulted in a cost estimate of $7.50 per analysis. Thus, the total estimated cost for the water analyses required during Phase II and Phase III is:

850 Analyses x $7.50 = $6,450.00

ADDITIONAL COSTS TO THE STATE OF MARYLAND

Additional costs will be incurred by the State of Maryland. These costs will include but not be limited to the following items:

- Salary of the Project Director.
- Salary of the Administrator of the Cumberland Lab.
- Secretarial Salaries.
- Overhead on These Salaries
- Expenses
  - Transportarion
  - Telephone
  - Lodging
  - Meals
  - Mailing and Reproduction
- Report Presentation

These expenses must be evaluated in determining the project costs. However, this determination is beyond the scope of this study.

RECOVERY FROM SALE OF COAL

An estimated 45,000 tons (40,800 metric tons) of coal remain in place. If the sale price for the coal in the pit is estimated at $4.25, the recovery from the sale of the coal would be an estimated $191,000.

The preceding estimate is based on:

25 acres (10.1 hectares) to be stripped.

36 inches (91 centimeters) of salable coal.

33% representing the probably minimum coal in place considering the dates and records of deep mining.

ADJUSTMENT FOR PRESENTLY UNRECLAIMED STRIP MINE

About 15 acres (6.1 hectares) of unreclaimed Buffalo Coal Company strip mine area remain. Buffalo Coal Company must reclaim this disturbed area under their existing permit. Since an estimated cost of reclaiming this land at $300 per acre (.4047 hectares) would be $4,500, a credit of this amount should be considered in the project costs.

This credit will appear either as a deduction from construction costs should Buffalo Coal Company be awarded the contract for the work or an assessment against Buffalo Coal Company should others do the work.

SECTION VIII

APPENDIX A

TABLES 1-16

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04	--	--	3.6	210	--	--	65	30	--	6.00	--	--	--	80	0	--	--	--
10/11	--	--	3.2	445	--	--	162	128	--	16.90	--	--	--	160	0	--	--	--
10/18	20	--	3.1	480	37	--	152	30	--	16.80	--	--	--	150	0	--	--	--
10/24	--	--	3.1	---	--	202	100	130	--	2.80	--	--	--	130	0	--	--	--
10/31	--	0.0	3.0	---	29	--	90	96	--	19	--	.10	.50	160	0	--	--	--
11/07	.80	9.0	3.4	478	--	181	235	100	45	15.5	1.80	2.00	.70	71	0	--	--	6.1
11/14	.230	6.0	3.9	---	960	--	825	44	--	9.50	--	--	--	50	--	--	--	--
11/21	5.0	4.0	3.7	230	21	96	60	38	10	8.0	1.30	.10	.60	63	0	--	--	4.6
11/28	1.0	3.5	4.1	---	20	--	40	36	--	7.80	--	--	--	60	0	--	--	--
12/05	6.7	5.0	3.8	185	--	85	--	--	2	--	.80	1.20	.30	--	--	--	--	5.1
12/12	20	4.5	3.5	---	20	--	80	60	--	11.30	--	--	--	93	0	--	--	--
12/19	18	3	4	290	--	137	--	--	28	--	1	2.10	.20	--	--	--	--	5.6
12/26	8.8	5.0	3.2	---	4	--	48.0	330	--	14.20	--	--	--	113	0	--	--	--
1/02	5.0	2.5	3.7	290	--	97	--	--	26.0	6.60	.70	1.70	.10	--	--	--	4.7	4.8
1/09	3.7	0	4.0	250	15	124	78.0	44.0	18.0	9.50	.40	1.80	.60	93.0	0	.50	5.0	5.6
1/16	3.7	3.0	4.6	215	--	--	55	36	--	6.90	--	.10	.10	65	1.0	--	--	--
1/23	3.6	--	4.1	---	6.0	102	60	26	8.0	8.20	--	--	--	--	0		--	--
1/30	3.1	--	3.4	320	24	142	75	26	--	9.50	--	--	--	100	0	--	--	--
2/06	--	31	3.4	255	19	108	64	42	22	11.80	.40	.10	.60	106	0	.50	6.4	5.1
2/13	8	0 (c)	3.7	280	31	124	60	58	--	8.10	--	--	--	28	0	--	--	--

TABLE 1 RESULTS OF WATER QUALITY DATA AT STATION No. 1

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11	--	--	6.0	155	--	--	280	4.0	--	.10	--	--	--	48	10	--	--	--
10/18	5	--	6.1	165	3.0	--	29	0	--	.10	--	---	--	50	12	--	--	--
10/24	--	--	6.7	--	---	57	5.2	8.0	--	.10	--	--	--	51	120	--	--	--
10/31	--	7.0	7.0	--	0	--	17	4.0	--	.10	--	.10	.10	56	14	--	--	--
11/07	.40	6.0	5.8	130	--	72	6.0	10	0	.10	.10	1.80	.10	40	12	--	--	9.6
11/14	.387	7.0	6.1	--	102	--	74	6.0	--	1.50	--	--	--	35	4.0	--	--	--
11/21	3.6	3.5	5.7	130	3.0	82	11.0	16.0	0	.50	.10	.10	.30	50	4.0	--	--	10
11/28	.61	2.0	6.9	--	4	--	11	2.0	--	.10	--	--	--	45	6.0	--	--	--
12/05	2.5	5.0	5.9	125	--	74	--	--	0	--	.10	.10	.30	--	--	--	--	10
12/12	3	3.5	5.6	--	3	--	20	6.0	--	.10	--	--	--	55	4.0	--	--	--
12/19	2.5	1.0	6.5	155	--	89	--	--	0	--	.10	.10	.10	--	--	--	--	9.5
12/26	4.0	4.5	5.5	--	8	--	56	22	--	.10	--	---	--	50	4.0	--	--	--
1/02	2.0	1.0	6.8	135	--	77	--	--	0	.30	.10	2.50	.10	--	--	--	8.3	9.5
1/09	8.5	0	6.7	155	4	89	18	20	0	.10	.10	.10	.50	53	10	.50	7.5	9.6
1/16	8.5	2.0	7.4	140	--	--	22	2.0	--	.10	--	.10	.10	50	20	--	--	--
1/23	5.4	--	7.4	--	0	91	29	0	0	.10	--	--	--	--	12	--	--	--
1/30	1.8	--	6.5	122	3.0	83	50	4.0	--	.50	--	--	--	45	6.0	--	--	--
2/06	--	31	5.8	125	0	81	13	4.0	0	.10	.10	.10	.30	40	6.0	.50	7.7	8.3
2/13	8	-1.0(c	6.8	140	3.0	102	19	8.0	--	.10	--	--	--	25	8.0	--	--	--

TABLE NO. 2

TABLE 2 RESULTS OF WATER QUALITY DATA AT STATION No. 2

DATE	FLOW (c.f.s.)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (ml/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04	--	--	3.0	560	--	--	133	110	--	18	--	--	--	200	0	--	--	--
10/11																		
10/18	--	--	3.3	350	12	--	71	70	--	0.70	--	--	--	105	0	--	--	--
10/24	--	--	3.3	--	--	150	58	100	--	9.20	--	--	--	96	0	--	--	---
10/31	--	8.0	--	--	---	--	--	--	--	11.50	--	.10	.30	--	--	--	--	--
11/07	1.50	8.0	3.9	235	--	92	65	36	14	7.8	1.5	2.20	.40	64	0	--	--	5.9
11/14	.700	7.0	5.1	--	748	--	925	32	--	9.20	--	--	--	20	1.0	--	--	--
11/21	80	4.0	4.0	175	11	72	42	26	6.0	4.3	.85	.10	.20	50	0	--	--	5.4
11/28	12.5	3.0	4.3	--	8	--	34	20	--	5.10	--	--	--	55	0	--	--	--
12/05																		
12/12																		
12/19																		
12/26																		
1/02																		
1/09																		
1/16																		
1/23																		
1/30																		
2/06	--	31	3.6	330	12	76	38.0	18.0	8.0	5.3	0.3	.10	.50	58	0	.50	5.3	4.5
2/13	--	--	3.7	245	14	115	51.0	34.0	--	7.40	--	--	--	50	--	--	--	--

TABLE 3 RESULTS OF WATER QUALITY DATA AT STATION No. 3

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04	--	--	3.0	600	--	--	90	106	--	13.80	--	--	--	230	0	--	--	--
10/11																		
10/18	--	--	3.4	360	12	--	70	66	--	8.50	--	--	--	125	0	--	--	--
10/24	--	--	3.3	--	--	174	67	130	--	8.50	--	--	--	115	0	--	--	--
10/31	--	8.0 (c)	3.3	--	10	--	50	56	--	7.90	--	.10	.60	106	--	--	--	--
11/07	3.80	8.0	4.3	220	--	107	92	30	6.0	5.70	1.20	3.30	.60	78	0	--	--	7.9
11/14	.142	7.0	6.2	--	1392	--	1500	6.0	--	13.80	--	--	--	60	14	--	--	--
11/21	85	4.0	4.3	238	14	142	42	86	4.0	3.60	1.05	.10	1.20	106	0	--	--,	11.8
11/28	3.57	3.5	4.5	--	10	--	35	26	--	4.30	--	--	--	100	0	--	--	--
12/05	9	5.5	4.3	225	--	126	--	--	1:0	--	.50	.20	1.40	--	--	--	--	10.6
12/12	24	3.0	3.9	--	5.0	--	44	30	--	3.0	--	--	--	113	--	--	--	--
12/19	25	2.5	4.6	245	--	148	--	--	0	--	.60	1.20	.70	--	--	--	--	10.0
12/26	84.3	5.0	3.9	--	6.0	--	35	58	--	1.0	--	--	--	103	0	--	--	--
1/02	7.7	2.0	4.5	255	--	117	--	--	0	4.70	.50	1.50	.10	--	--	--	7.9	10.2
1/09	8.5	3.0	4.5	235	12	130	50	22	0	5.0	.50	1.80	.80	86	0	.50	7.6	10.3
1/16	8.5	4.0	5.2	260	--	--	60	46	--	6.20	--	2.00	.20	106	18	--	--	--
1/23	9.7	--	4.1	--	4.0	155	52	26	10	3.5	--	--	--	--	0	--	--	--
/30	5.9	--	4.1	198	6.0	115	39	22	--	2.10	--	--	--	78	0	--	--	--
5	--	31	6.4	75	3.0	49	15	4.0	0	.20	.10	.10	.20	20	8.0	.50	5.6	4.0
2/13	21	0 (c)	4.2	225	3.0	152	39	22	--	2.80	--	--	--	65	0	--	--	--

TABLE 4 RESULTS OF WATER QUALITY DATA AT STATION No. 4

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	--	--	4.9	80	4	--	30	8.0	--	--	.20	--	--	25	1.0	--	--	--
10/24	--	--	5.2	--	--	50	5.0	16	--	--	.20	--	--	26	4.0	--	--	--
10/31	--	10	5.1	--	0	--	13	6.0	--	--	.20	.10	.10	28	2.0	--	--	--
11/07	5.0	9.0	4.9	98	--	38	6.0	8.0	.10	0	.10	1.60	.10	27	6.0	--	--	5.6
11/14	.075	7.5	5.1	--	13	--	50	10	--	--	.50	--	--	28	1.0	--	--	--
11/21	.005	5.0	5.3	78	0	46	6.0	10	.10	0	.20	.10	.10	25	2.0	--	--	5.1
11/28	.007	4.0	5.2	--	0	--	7.0	8.0	--	--	.10	--	--	26	6.0	--	--	--
12/05	.063	4.0	5.2	75	--	45	--	--	.10	0	--	.10	.10	--	--	--	--	5.3
12/12	.009	4.0	5.2	--	0	--	7.0	10	--	--	.10	--	--	25	2.0	--	--	--
12/19	.003	3.5	5.7	80	--	49	--	--	.10	0	--	.10	.10	--	--	--	--	4.3
12/26	.005	4.0	5.1	--	0	--	16	10	--	--	3.50	--	--	27	1.0	--	--	--
1/02	.004	4.0	5.3	75	--	34	--	--	.10	0	.30	1.90	.10	--	--	--	3.7	4.3
1/09	.5	3.0	5.7	80	0	42	10	2.0	.10	0	.10	.10	.30	26	4.0	.5	3.8	4.4
1/16	.5	4.0	6.6	78	--	--	11	2.0	--	--	.10	.10	.10	76	14	--	--	--
1/23	.4	--	6.0	--	0	43	22	12	--	0	1.10	--	--	--	6.0	--	--	--
1/30	.2	--	5.1	80	0	41	11	6.0	--	--	.40	--	--	25	4.0	--	--	--
2/06	--	31	5.0	80	0	48	3.0	6.0	.10	0	.20	.10	.20	22	2.0	.50	4.6	4.5
2/13	.1	3.0 (c	5.8	75	2	58	8.0	34	--	--	.10	--	--	17	4.0	--	--	--

TABLE 5 RESULTS OF WATER QUALITY DATA AT STATION No. 5

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	--	--	6.6	125	1.0	--	28	10	--	.10	--	--	--	42	6.0	--	--	--
10/24	--	--	5.9	--	--	71	6.0	4.0	--	.30	--	--	--	38	6.0	--	--	--
10/31	--	9.0	7.1	--	2.0	--	22	2.0	--	.20	--	.12	.10	48	2.0	--	--	--
11/07	.05	9.0	5.1	102	0	45	7.0	10	0	1.00	.10	1.20	.10	30	6.0	--	--	5.4
11/14	.330	7.5	5.8	--	49	--	60	34	--	.60	--	--	--	24	4.0	--	--	--
11/21	.120	5.5	5.4	78	0	49	6.0	6.0	0	4.0	.10	.10	.10	20	2.0	--	--	4.8
11/28	.139	5.0	6.4	--	0	-	5.0	2.0	--	.10	--	--	--	23	4.0	--	--	--
12/05	.150	5.5	6.0	75	--	43	--	--	0	--	.10	.10	.10	--	---	--	--	4.6
12/12	.520	5.0	5.5	--	0	--	6.0	8.0	--	.10	--	--	--	20	6.0	--	--	--
12/19	.125	4.0	6.2	70	--	51	--	--	0	--	.10	.10	.10	--	--	--	--	4.1
12/26	.084	5.0	5.2	--	0	--	17	8.0	--	.10	--	--	--	21	2.0	--	--	---
1/02	.042	4.0	7.0	75	--	34	--	--	0	.30	.10	.80	.10	--	--	--	4.5	4.8
1/09	.6	3.0	6.4	95	1.0	52	13	2.0	0	.10	.10	.10	.30	26	10	.50	4.2	4.4
1/23	.8	--	6.4	--	0	61	17	8.0	0	1.20	--	--	--	--	8.0	--	--	--
1/30	.5	--	6.0	75	0	38	17	6.0	--	.30	--	--	--	26	2.0	--	--	--
2/06	--	--	5.9	70	29	50	22	6.0	0	.10	.10	.10	.20	21	8.0	.50	5.2	4.1
2/13	.09	3.0(c)	6.2	75	1.0	53	6.0	8.0	--	.10	--	--	--	19	4.0	--	--	--
1/16	6	4.0	6.7	205	--	--	22	8.0	--	.10	--	2.50	1.60	200	16	--	--	--

TABLE 6 RESULTS OF WATER QUALITY DATA AT STATION No. 6

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	--	--	5.6	5.5	7.0	--	32	14	--	.10	--	--	--	262	2.0	--	--	--
10/24	--	--	6.3	--	--	382	7.0	18	--	.50	--	--	--	270	6.0	--	--	--
10/31	--	8.0	6.9	--	7.0	--	42	4.0	--	.10	--	.10	2.8	200	12	--	--	--
11/07	.20	9.0	5.4	425	--	299	17	24	0	.10	.10	3.5	3.40	210	4.0	--	--	42
11/14	.150	8.0	6.4	--	1988	--	1600	20	--	18.90	--	--	--	150	20	--	--	--
11/21	2.67	3.5	5.1	442	8.0	316	22	54	0	2.10	1.00	2.10	3.70	230	1.0	--	--	36
11/28	.420	3.0	5.3	--	6.0	--	18	30	--	1.10	--	--	--	190	4.0	--	--	--
12/05	.100	6.0	4.8	375	--	271	--	--	0	--	.70	3.70	3.20	--	--	--	--	42
12/12	1.16	2.5	4.6	--	0	--	21	40	--	1.30	--	--	--	240	1.0	--	--	--
12/19	.750	2.0	5.3	425	--	336	--	--	0	--	.10	.90	3.30	--	--	--	--	40
12/26	1.25	4.5	4.4	--	0	--	40	82	--	.10	--	--	--	200	0	--	--	--
1/02	.330	0	5.7	440	--	302	--	--	0	.30	.10	2.80	10	--	--	--	11	35
1/09	1.1	3.0	5.9	295	11	232	30	8.0	0	.10	.10	.10	2.9	190	4.0	.50	11.6	38
1/16	1.1	4.0	6.9	145	--	--	11	4.0	--	.10	--	.10	.10	45	14	--	--	--
1/23	1.3	--	6.7	--	1.0	326	20	2.0	0	.90	--	--	--	--	6.0	--	--	--
1/30	.9	--	5.7	317	10	240	270	8.0	--	.60	--	--	--	160	2.0	--	--	--
2/06	--	31	4.5	300	7.0	211	21	24	0	2.60	.10	.10	1.60	150	0	.50	10.2	15.6
2/13									SIT	FF	ROZ	EN						

TABLE 7 RESULTS OF WATER QUALITY DATA AT STATION No. 7

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	--	--	2.5	2900	1.0	--	15	1880	--	302	--	--	--	2620	0	--	--	--
10/24	--	--	2.5	--	--	3693	5.0	1680	--	320	--	--	--	1720	0	--	--	--
10/31	--	9.0	--	--	--	--	--	--	--	54.10	--	52	7.60	--	--	--	--	--
11/07	.60	10	2.8	2900	--	3617	7.0	1640	1110	340	.10	68	7.20	2870	0	--	--	99
11/14	.160	10	2.5	--	69	--	55	144	--	364	--	--	--	2570	0	--	--	--
11/21	.581	9.0	2.7	2500	1.0	2508	6.0	1240	780	340	8.60	42	6.20	1420	0	--	--	92.0
11/28	.350	10	3.2	--	1.0	--	3.0	1030	--	284	--	--	--	1720	0	--	--	--
12/05	.410	9.5	2.6	2500	--	18	--	--	800	--	16	38	6.00	--	--	--	--	86
12/12	.420	10	2.7	--	0	--	6.0	1500	--	145	--	--	--	125	0	--	--	--
12/19	.200	10	2.8	2500	--	1974	--	--	1180	--	3.0	23	4.20	--	--	--	--	75
12/26	.174	10	2.4	--	0	--	9.0	780	--	148	--	--	--	1100	0	--	--	--
1/02	.139	10	3.0	2100	--	1827	--	--	590	119	3.0	19.80	.10	--	--	--	12.5	58
1/09	1.6	2.0	3.2	2200	0	1961	11	710	460	90	2.60	25	4.0	1550	0	.50	3.0	44
1/16	1.6	0	3.6	2100	--	--	13	1000	--	168	--	13.30	4.80	1600	0	--	--	--
1/23	1.8	--	3.5	--	0	2136	11	910	530	126	--	--	--	--	0	--	--	--
1/30	.5	--	2.3	2195	0	2138	16	1020	--	158	--	--	--	1670	0	--	--	--
2/06	--	--	2.4	2090	1.0	2039	8.0	940	650	204	5.00	3.50	4.70	1370	0	.50	15.5	74.0
2/13	4	10 (c	2.7	2200	2.0	80	6.0	850	--	163	--	--	--	900	0	--	--	--

TABLE 8 RESULTS OF WATER QUALITY DATA AT STATION No. 8

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04	--	--	2.7	2210	--	--	34	1060	--	142	--	--	--	1060	0	--	--	--
10/11	--	--	3.0	1370	--	--	21	560	--	44	--	--	--	69	0	--	--	--
10/18	1.4	--	2.8	1900	2.0	1884	37	644	356	56	7.0	14.8	15.60	1370	0	--	--	--
10/24	--	--	2.9	--	--	2141	4.0	750	--	18.30	--	--	--	1420	0	--	--	--
10/31	--	10	2.9	--	--	1229	40	342	--	24	10	16.70	11.60	720	0	--	--	--
11/07	3.5	12	3.2	2100	0	2203	11	732	308	61	1.80	86	13.20	1360	0	--	--	107
11/14	.095	7.0	3.0	--	50	--	65	308	--	26	--	--	--	500	0	--	--	--
11/21	.021	4.0	3.2	1150	6.0	867	15	262	96	52	3.00	17.70	11.20	400	0	--	--	76
12/05	.010	8.0	3.1	1010	--	723	--	--	90.0	--	1.00	15.00	9.90	--	--	--	--	54
12/12	.012	3.0	3.2	--	0	--	22	164	--	11.80	--	--	--	360	0	--	--	--
12/19	.014	1.0	3.8	990	--	783	--	--	92.0	--	2.00	13.00	9.00	--	--	--	--	4.90
12/26	.017	3.0	3.0	--	1.0	--	56	290	--	11.50	--	--	--	330	0	--	--	--
1/02	.650	2.0	3.6	1090	--	818	--	--	86	8.20	1.90	11.50	14.10	--	--	--	12.8	65
1/09																		
1/16	.5	1.0	4.3	1160	--	--	11	272	--	18.60	--	14.40	12.80	650	0	--	--	--
1/23	.8	--	3.9	--	0	1216	17	256	48	14.40	--	--	--	--	0	--	--	--
1/30				------	------	------	SITE FROZEN --					------	------					
2/06	--	31	2.9	945	11	765	65	190	70	12.90	.40	.10	9.70	464	0	.50	52	51
2/13				------	------	------	SITE FROZEN --					------	------					
11/28	.001	2.0	3.6	--	6.0	--	9.0	218	--	19.80	--	--	--	448	0	--	--	--

TABLE 9 RESULTS OF WATER QUALITY DATA AT STATION No. 9

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04	--	--	2.7	3050	--	--	36	1140	--	110	--	--	--	2700	0	--	--	--
10/11	--	--	2.9	1850	--	--	30	890	--	56	--	--	--	920	0	--	--	--
10/18	1.2	--	2.9	1420	4.0	1240	50	434	202	40	19	9.10	13.20	740	0	--	--	--
10/24	--	--	3.0	--	--	1174	5.0	360	--	50	--	--	--	93	--	--	--	--
10/31	--	10	2.8	--	1.0	--	32	760	--	30.10	--	39.60	18.90	2050	0	--	--	--
11/07	.0	14	3.3	2300	--	2406	8.0	572	174	17.50	1.50	19.50	36	1800	0	--	--	138
11/14	.090	7.0	3.0	--	69	--	140	310	--	20	--	--	--	480	0	--	--	--
11/21	.011	3.0	3.1	850	5.0	575	17	192	76	30	5.00	10.50	7.20	360	0	--	--	52
11/28	.021	1.0	3.7	--	12	--	9.0	150	--	18.10	--	--	--	240	0	--	--	--
12/05	.026	8.0	3.1	765	--	529	--	--	88	--	3.20	8.20	6.40	--	--	--	--	54
12/12	.024	2.5	3.4	--	2.0	--	29	92	--	6.70	--	--	--	226	0	--	--	--
12/19	.013	1.0	4.1	590	--	376	--	--	44	--	2.60	4.90	3.00	--	--	--	aa	30.0
12/26	.021	3.0	3.1	---	0	--	8.0	250	--	.10	--	--	--	212	0	--	--	--
1/02	.364	1.5	3.5	755	--	489	--	--	54	5.60	2.70	7.00	.20	--	--	--	11.0	39.0
1/09	1.0	-7.0	3.9	800	13	504	13	122	40	7.60	1.40	8.60	3.70	330	0	50	28	51
1/16	1.0	0	4.5	330	--	--	22	128	--	9.10	--	7.30	4.00	360	0	--	--	--
1/23	1.2	--	4.3	--	1.0	632	29	104	12	6.80	--	--	--	--	0	--	--	--
1/30				------	------	S I T	E F	R O Z	E N	------	------	--						
2/06	--	31	3.2	.625	1	493	11	124	50	11.2	2.8	0.1	3.9	305	0	5	10.8	42.0
2/13				------	------	S I T	E F	R O Z	E N	------	------	--						

TABLE 10 RESULTS OF WATER QUALITY DATA AT STATION No. 10

TABLE II RESULTS OF WATER QUALITY DATA AT STATION No. 11

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY ($mg/l\ CaCO_3$)	MINERAL ACIDITY ($mg/l\ CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY ($mg/l\ CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	--	--	4.6	705	3.0	--	5	86	--	.50	--	--	--	180	1.0	--	--	--
10/25	--	--	4.5	--	--	529	6.0	48	--	1.00	--	--	--	350	0	--	--	--
10/31	--	10	4.8	--	4.0	--	60	42	--	.50	--	.10	2.10	334	1.0	--	--	--
11/07	.60	10	4.8	660	--	621	12	92	0	1.50	.10	5.20	7.20	818	4.0	--	--	58
11/14	.210	7.0	6.2	--	250	--	620	84	--	6.20	--	--	--	172	2.0	--	--	--
11/21	3.11	9.0	6.0	595	6.0	450	22.0	92.0	8.0	4.20	2.1	7.50	6.10	270	0	--	--	40.0
11/28	.830	2.0	6.7	--	5.0	--	22.0	60.0	--	2.50	--	--	--	287	1.0	--	--	--
12/05	.950	7.0	6.7	605	--	180	--	--	0	--	1.00	7.60	5.10	--	--	--	--	54.0
12/12	.700	2.5	6.4	--	0	--	10	30	--	2.50	--	--	--	299	0	--	--	--
12/19	.720	7.0	5.1	540	--	452	--	--	0	--	.10	1.10	5.00	--	--	--	--	46.0
12/26	1.02	8.5	6.2	--	0	--	15	116	--	.10	--	--	--	257	0	--	--	--
1/02	.900	0	6.2	570	--	431	--	--	0	90	.10	1.80	2.50	--	--	--	11.5	48.0
1/09	1.5	1.0	5.5	52.0	9.0	411	25.0	34.0	0	70	.10	1.50	4.40	242	6.0	.50	34.0	42.0
1/16	1.5	3.0	5.8	540	--	--	22	28	--	10	--	.20	4.50	297	12	--	--	--
1/23	1.6	--	6.0	--	2.0	402	22	16	0	90	--	--	--	--	9.0	--	--	--
1/30	1.4	--	5.1	660	10	352	60	36	--	60	--	--	--	224	2.0	--	--	--
2/05	--	11	6.8	675	5.0	301	16	56	0	30	.10	1.0	4.40	232	3.0	.50	11.6	48.0
2/13	1	0 (ice)	5.1	500	22	425	50	18	--	.60	--	--	--	155	2.0	--	--	--

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	--	--	5.3	164	5.0	--	30	8.0	--	.50	--	--	--	65	2.0	--	--	--
10/24	--	--	5.8	--	--	106	5.0	9.0	--	.70	--	--	--	35	4.0	--	--	--
10/31	--	8.0	7.1	--	0	--	60	8.0	--	.20	--	.10	.10	62	4.0	--	--	--
11/07	1.80	7.0	5.5	125	--	77	17	12	0	1.10	.10	1.00	.20	57	12	--	--	10.5
11/14	.850	8.0	5.5	--	716	--	700	20	--	7.90	--	--	--	20	6.0	--	--	--
11/21	50	4.0	5.2	130	6.0	80	17.0	8.0	0	.50	.10	.10	.50	55	2.0	--	--	9.2
11/28	17.1	3.0	6.4	--	5.0	--	17.0	6.0	--	.20	--	--	--	48	4.0	--	--	--
12/05	32	5.0	5.5	120	--	65	--	--	0	--	.10	.10	.60	--	--	--	--	9.4
12/12	40	3.0	4.9	--	12	--	45	14	--	.20	--	--	--	48	2.0	--	--	--
12/19	32	2.0	5.6	145	--	97	--	--	0	--	.10	.20	.40	--	--	--	--	9.7
12/26	31.4	5.0	5.0	--	11	--	35	28	--	.10	--	--	--	45	1.0	--	--	--
1/02	17	1.5	6.6	140	--	67	--	--	0	.40	.10	1.40	.10	--	--	--	6.7	8.9
1/09	32.5	2.0	6.1	140	8.0	85	19.0	4.0	0	.10	.10	.10	.70	53	6.0	.50	6.5	10.0
1/16	32.5	4.0	6.8	135	--	--	27	6.0	--	.10	--	.10	.20	58	12	--	--	--
1/23	33	--	4.3	--	0	147	35	22	4.0	1.40	--	--	--	--	0	--	--	--
1/30	23	--	6.0	125	15	70	45	2.0	--	.50	--	--	--	50	4.0	--	--	--
2/06	--	--	5.7	120	6.0	74	12	8.0	0	.50	.10	.10	.60	40	2.0	.50	6.6	8.2
2/13	35	0 (c)	6.4	125	14	84	37	12	--	.20	--	--	--	11	4.0	--	--	--

TABLE 12 RESULTS OF WATER QUALITY DATA AT STATION No. 12

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (ml/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	--	--	4.2	250	4.0	--	16	30	--	1.50	--	--	--	95	0	--	--	--
10/24	--	--	4.1	--	--	135	11	26	--	1.40	--	--	--	90	0	--	--	--
10/31	--	7.0	3.4	--	5.0	--	21	42	--	.80	--	.10	.70	120	0	--	--	--
11/07	2.50	7.0	4.6	193	--	93	20	20	0	2.60	.10	2.10	.80	70	2.0	--	--	11.1
11/14	.750	7.5	6.0	--	672	--	850	70	--	8.30	--	--	--	25	2.0	--	--	--
11/21	66.7	3.0	5.2	145	16	80	32.0	14	0	1.60	.10	.10	.30	59.0	2.0	--	--	9.1
11/28	60	3.5	5.3	--	6.0	--	20.0	10	--	1.20	--	--	--	63.0	4.0	--	--	--
12/05	120	5.0	5.2	125	--	76	--	--	0	--	.10	1.00	.60	--	--	--	--	8.5
12/12	90	3.0	4.6	--	7.0	--	60	14	--	1.00	--	--	--	55	1.0	--	--	--
12/19	60	2.0	5.7	135	--	87	--	--	0	--	.10	30	.30	--	--	--	--	9.1
12/26	78.1	5.0	4.1	--	0	--	22	30	--	.10	--	--	--	55	0	--	--	--
1/02	40	1.5	5.0	150	--	78	--	--	0	.60	.10	.00	.10	--	--	--	6.7	9.6
1/09	27	1.0	4.5	200	3.0	127	26	24	0	2.20	.10	1.00	.30	86.0	0	.50	7.6	10.4
1/16	27	3.0	5.0	285	--	--	29	32	--	3.90	--	1.00	.10	100	8.0	--	--	--
1/23	29	--	7.0	--	2.0	94	29	2.0	0	1.20	--	--	--	--	6.0	--	--	--
1/30	15	--	4.1	170	0	94	29	20	--	1.60	--	--	--	71	0	--	--	--
2/06	--	--	3.7	195	7.0	104	25	20	4.0	2.30	.10	.10	.60	75	0	.50	8.0	9.3
2/13	24	4.0c	3.9	245	1.0	135	30	32	--	2.20	--	--	--	65	0	--	--	--

TABLE 13 RESULTS OF WATER QUALITY DATA AT STATION No. 13

DATE	FLOW (cfs)	TEMPERATURE (°F)	pH	SPECIFIC CONDUCTANCE (umhos/cm @ 25°C)	SUSPENDED SOLIDS (mg/liter)	DISSOLVED SOLIDS (mg/liter)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON	ALUMINUM (mg/l Al)	MANGANESE (mg/l Mn)	SULFATE (mg/l SO_4)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/liter)	MAGNESIUM (mg/l Mg)	CALCIUM (mg/l Ca)
10/04																		
10/11																		
10/18	1.0	--	3.1	2300	3.0	2391	29	466	106	9.60	5.3	10.50	38	1670	0	--	--	--
10/24	--	--	3.1	--	--	164	79	410	--	8.00	--	--	--	896	0	--	--	--
10/31	--	10	3.0	--	5.0	--	55	350	--	9.10	--	25.20	15.80	896	0	--	--	--
11/07	3.5	12	3.1	1550	0	1368	16	526	256	65	22	18.50	12	1100	0	--	--	65
11/14	.670	10	3.2	--	38	--	57	372	--	15.50	--	--	--	130	--	--	--	--
11/21	.010	5.0	3.3	2025	1.0	2063	6.0	568	98	18.40	4.20	44	38	1670	0	--	--	140
11/28	.022	4.0	3.8	--	33	--	26	320	--	15.30	--	--	--	870	0	--	--	--
12/05	.035	10.0	3.3	1725	--	1659	--	--	82	--	1.70	38	30	--	--	--	--	118
12/12	.025	6.0	3.4	--	0	--	6.0	438	--	5.70	--	--	--	944	0	--	--	--
12/19	.010	3.5	3.8	1500	--	1541	--	--	40	--	2.80	16.70	19.70	--	--	--	--	106
12/26	.006	5.0	3.2	--	1.0	--	23.0	600	--	2.00	--	--	--	850	0	--	--	--
1/02	.037	2.0	4.0	1400	--	1823	--	--	42	3.30	2.80	14.70	13.60	--	--	--	13.7	82
1/09	.5	-7.0	4.0	925	9.0	1041	19.0	174	22.0	4.70	1.60	14.8	11.10	750	0	.50	78	84
1/16	.5	-2.0	5.9	1100	--	--	11.0	108	--	3.10	--	7.20	9.90	750	24	--	--	--
1/23	.7	--	4.1	--	4.0	929	22	146	16	2.60	--	--	--	--	0	--	--	--
1/30	.2	--	3.3	1120	5.0	1058	23	208	--	3.50	--	--	--	700	0	--	--	--
2/06	--	31	3.3	1100	11	1022	22	198	34	5.10	.80	2.00	11.80	610	0	.50	74	7.8
2/13	SITE	FROZEN																

TABLE 14 RESULTS OF WATER QUALITY DATA AT STATION No. 14

STA.	LOCATION	HIGH AVERAGE LOW	pH	FLOW CFS	CONCENTRATION MG/LITER				LOAD LB/DAY		
					ACID	ALK.	IRON	SULFATE	ACID	IRON	SULFATE
8	GILMAN MINE	High	3.2	1.6	1500		340	1720	6120	1060	13,370
		Average	2.8	0.5	1050	0	190	1410	2830	512	3,800
		Low	2.4	0.14	710		90	1100	730	90	1,030
1	SOUTH PRONG AT UPPERMAN ROAD BRIDGE	High	4.1	20.0	60		14.2	113	6500	1220	10,000
		Average	3.7	8.5	45	0	9.6	85	2060	440	3,900
		Low	3.2	1.8	36		6.6	60	350	76	580
2	TRIBUTARY FROM WEST	High	6.9	8.5	22	10	0.5	55	920	10	2,400
		Average	6.2	3.3	13	5.6	0.2	51	230	4	910
		Low	5.5	0.6	2	4	0.1	45	7	0.3	150
11	EAST TRIBUTARY AT UPPERMAN ROAD CULVERT	High	6.2	3.5	116	6	4.2	293	1652	75	4,850
		Average	4.8	1.2	76	1.4	1.8	274	492	12	1,770
		Low	4.0	0.5	34	0	0.1	252	268	0.6	1,232
7	PRINCIPAL BRANCH OF EAST TRIB. AT S. PRONG	High	5.9	2.7	82	0	2.1	240	780	30	3,300
		Average	5.1	1.2	43	2.5	0.9	210	278	6	1,350
		Low	4.4	0.3	8	4	0.1	190	50	1	430
4	SOUTH PRONG BELOW EAST TRIBUTARY	High	4.5	25.0	58		5	113	4470	390	14,620
		Average	4.3	13.4	29	0	3.6	102	2090	260	7,370
		Low	3.9	3.6	3		1	86	390	77	1,920
13	SOUTH PRONG AT CONFLUENCE	High	5.7		38	4	2.2	86	---	---	---
		Average	5.0	24*	20	1.4	1.1	63.4	2590	142	8,200
		Low	4.3		10	0	0.1	55	---	---	---
12	NORTH PRONG AT CONFLUENCE	High	6.6	---	28	6	0.5	55	---	---	---
		Average	5.6	12*	12	3	0.3	50	775	19	3,230
		Low	4.9	---	4	1	0.1	45	---	---	---
9	BUFFALO STRIP EAST	High	3.8	0.02	290		30	380	27	29	35
		Average	3.4	0.01	200	0	16	335	11	0.9	27
		Low	3.0	0.01	150		8	240	11	0.8	21
10	BUFFALO STRIP WEST	High	4.1	1	262		52	450	658	41	1,780
		Average	3.5	0.24	190	0	15	323	250	20	420
		Low	3.1	.001	92		0.1	210	1	0.1	2.4
14	UPHOLE STRIP	High	4.0	0.5	600		18	1670	470	13	2,000
		Average	3.6	0.08	420	0	8	1015	180	3	440
		Low	3.2	0.01	174		2	750	20	0.06	28

NOTE: Average Loadings Based On Average Flows And Concentrations Estimated Flows

TABLE 15 SUMMARY OF WATER QUALITY DATA

WELL	DEPTH (FT.)	pH	SPECIFIC CONDUCTANCE (umhos/cm)	SUSPENDED SOLIDS (mg/l)	DISSOLVED SOLIDS (mg/l)	TURBIDITY (JCU)	TOTAL HOT ACIDITY (mg/l $CaCO_3$)	MINERAL ACIDITY (mg/l $CaCO_3$)	TOTAL IRON (mg/l Fe)	FERROUS IRON (mg/l Fe	ALUMINUM (mg/l)	MANGANESE (mg/l)	SULFATE (mg/l)	TOTAL ALKALINITY (mg/l $CaCO_3$)	SETTLEABLE SOLIDS (mg/l)	MAGNESIUM (mg/l)	CALCIUM (mg/l)
WILLIAM HERB	110	66	175	0	102	11.0	0	0	.20	.10	.10	.10	4.0	70	.50	8.8	29.0
VERNARD TASKER	Spring	4.3	275	0	204	1.0	55.0	1.0	.30	.10	1.0	2.3	97.0	0	.50	10.9	3.5
REESE TASKER	80'	6.8	265	4	179	65	0	0	4.3	2.1	.10	.60	72	60	.50	10.3	34
WOODWARD UPOLE	52'	5.9	185	0	112	3	0	0	.20	.10	.10	.20	38	20	.50	8.3	8
CATHERINE SINES	55'	5.6	70	0	45	5	4.0	0	.20	.10	.10	.30	14	6.0	.50	4.9	2.7
LESTER POUCH	104'	6.4	245	0	165	1	0	0	.20	.10	.10	.20	62	24	.50	10.5	26.0

TABLE 16 WATER WELL ANALYSES SAMPLES TAKEN FEBRUARY 6, 1973